HP StoreEver Tape Libraries Failover User Guide

HP Part Number: 5697-3519
Published: December 2014
Edition: Fourth

Acknowledgements

Contents

1 Overview

With today's high dependency on access to business information, safe-guarded data and limited backup windows, the reliability of the backup hardware and software is vital. Additionally, backup operations are usually automated, often done at night, and any first pass operator intervention is done remotely. To assist with these enterprise demands, HP provides High Availability Failover features for ESL G3 tape libraries and the MSL2024, MSL4048, MSL6480, MSL8048, and MSL8096 Tape Libraries with LTO-5 and later generation Fibre Channel tape drives. Failover features are not supported on the HP StoreEver EML and ESL E-Series Tape Libraries.

- High Availability Data Path Failover— Both of the tape drive's ports are connected to the SAN. Only one of the ports is used at any one time and the second port is a standby port. When a link failure on the active port is detected, the second port is used.
- High Availability Control Path Failover — Depending on the library and drive, one or both ports on the control path drive are configured to present a path to the library controller and a second drive is configured as a standby library control path drive. The library control path can be moved to a second link on the drive hosting the control path in the event of a single path failure and in the event of a complete control path drive connection loss, the standby library control path drive can be activated and connection to the library control path can be moved to that drive.

With LTO-5 and LTO-6 tape drives, a driverless path failover feature uses library and drive firmware to create a new Fibre Channel path to a drive or library if the original path is lost. Most applications recognize the new path and some will automatically retry commands after the original path is lost. Other applications may require user intervention to begin using the new path.

With LTO-6 tape drives, in addition to the driverless path failover feature, HP offers a driver-based path failover feature that uses drivers in conjunction with library and drive firmware to manage multiple paths across multiple SANs, present a single drive or library path to applications, and automatically transfer commands to the new path if the original path is lost. This transfer is invisible to most applications, avoiding the need for user intervention.

These failover features are presented in the library user interface as basic and advanced failover.

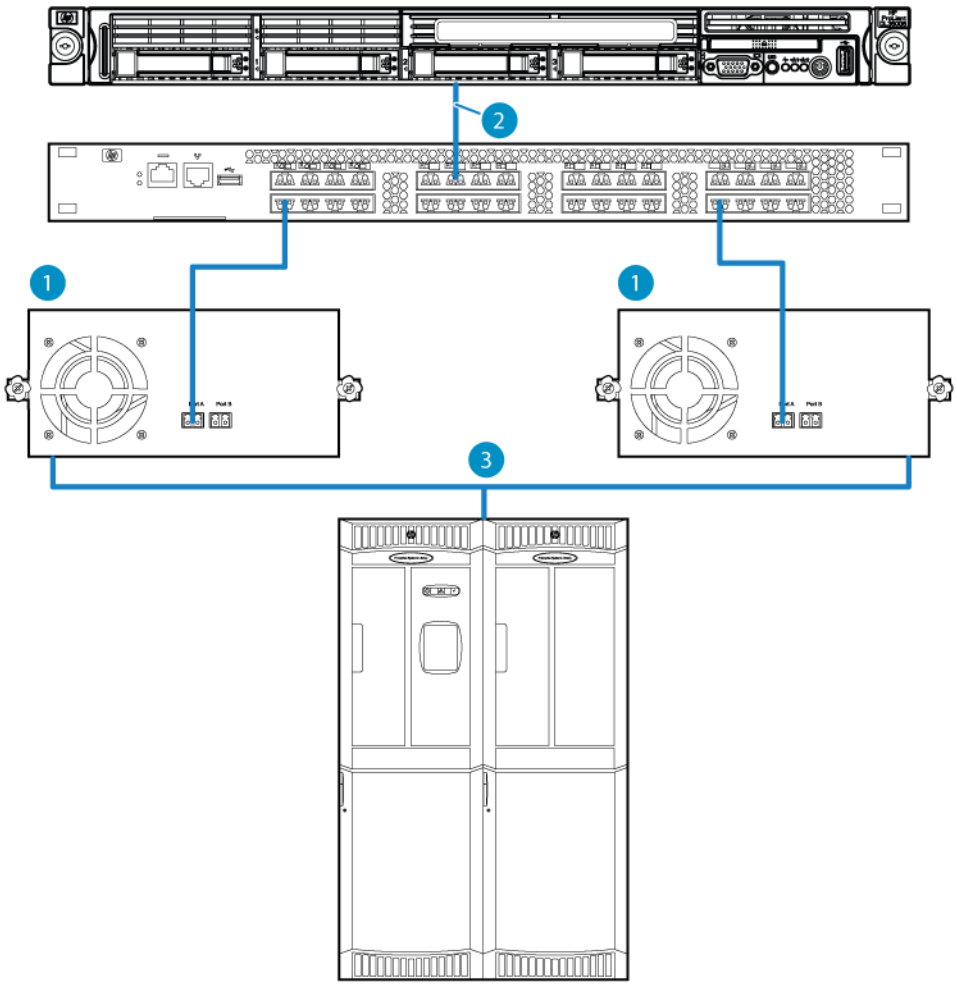
- Basic failover
  - Supported on LTO-5 and LTO-6 FC tape drives. Data path failover requires a dual-ported drive.
  - Supported by a combination of tape drive and library firmware features to create a new Fibre Channel path to a drive or library if the original path is lost.
  - Most applications recognize the new path and some applications will automatically retry commands after the original path is lost. Some applications might require user intervention to begin using the new path.
  - Is available for the MSL2024, MSL4048, MSL6480, MSL8048, MSL8096, and ESL G3 Tape Libraries.
- Advanced failover
  - Supported on LTO-6 FC tape drives.
  - Requires host driver support, in addition to tape drive and library firmware features, to manage multiple paths across multiple SANs, present a single drive or library path to applications, and automatically transfer commands to the new path if the original path is lost.
  - The transfer to the failover path is invisible to most applications, avoiding the need for user intervention.

- Is available for the ESL G3 and MSL6480 Tape Libraries.
- Is not available for the 1/8 G2 Tape Autoloader nor the MSL2024, MSL4048, MSL8048, or MSL8096 Tape Libraries.

Traditional library control path and drive connections without failover

A typical connection for a Fibre Channel tape library using the drive to bridge commands to the library controller in a two drive tape library is shown in "Typical bridged library controller connection" (page 7).

Figure 1 Typical bridged library controller connection

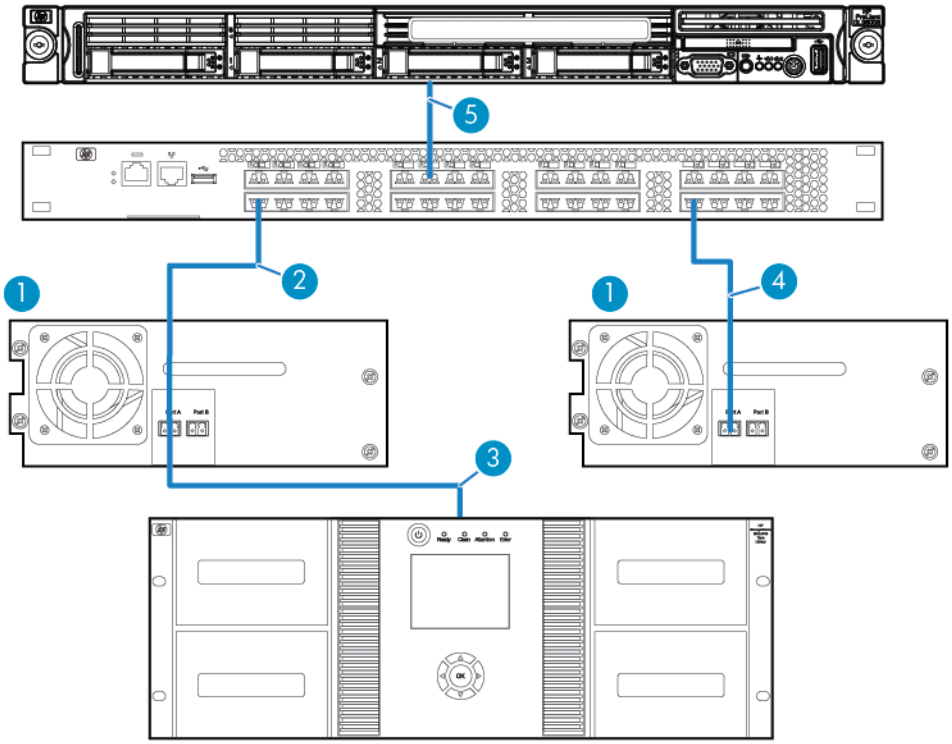


1. HP Ultrium Dual Port Fibre Channel Tape Drives
2. Host connection
3. Internal connection

In the typical bridged library controller connection each tape drive has one physical link to the SAN switch and connects to the SAN switch as one Fibre Channel device.

The tape drive hosting the library controller path connects as one Fibre Channel device containing two logical units. The tape drive is logical unit number zero and the tape library is logical unit number one. The tape library Fibre Channel device contains a tape drive logical unit and a media changer logical unit. The logical view of the tape library is shown in "Logical view of traditional configuration" (page 8).

Figure 2 Logical view of traditional configuration



1. HP Ultrium Dual Port Fibre Channel Tape Drives
2. Lun 0 at the WWPN of this drive
3. Lun 1 at the WWPN of this drive
4. Lun 0 at the WWPN of this drive
5. Host connection

Basic path failover

Basic path failover uses features in the tape drive and library firmware to recover paths following a link failure.

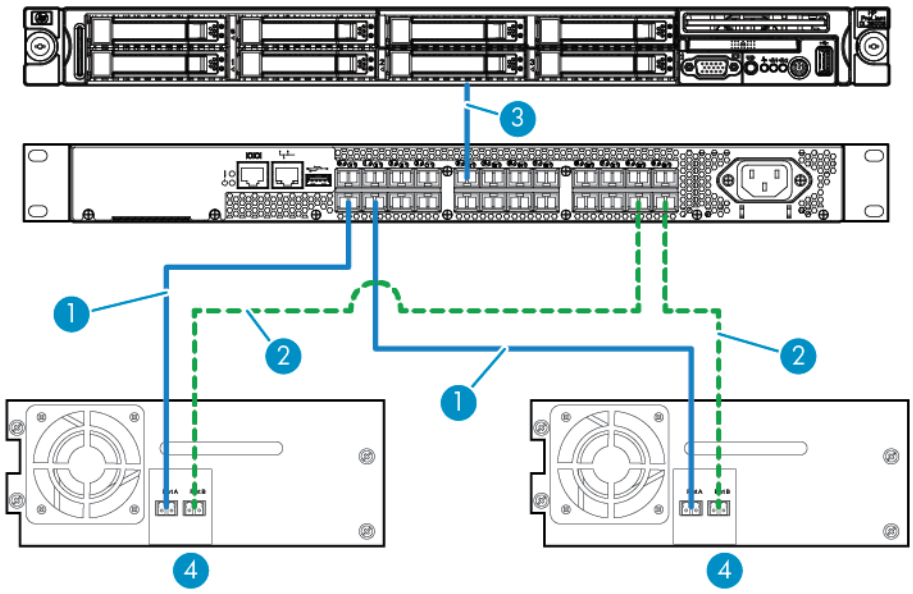
Basic data path port failover details

Basic data path port failover (see Figure 3 (page 9)) can be configured on each LTO-5 or LTO–6 dual-port Fibre Channel tape drive in the library. When basic data path port failover is configured, one link is active and is the primary data path. The second link is a standby data path. The drive verifies that the second link is able to receive a Fibre Channel signal and completes speed negotiation but the drive does not fully establish a connection using the standby link. The library user interface might report the standby link as a passive connection.

The drive monitors the links for errors, and following detection of a fault, transfers the fabric identity (world wide names) and all settings (mode parameters, encryption settings, etc.) over to the standby link and then activates that link. When properly configured, the change is minimally disruptive to the host and does not require any configuration changes on the host or in the backup application.

If no drive commands are outstanding when a failure is detected, the port change happens with virtually no disruption to the SAN. If a command is outstanding on the link when a failure is detected, the drive is not able to recover the command so that command fails but the application is able to continue to use the drive on the new path. Many applications are able to recover from a single command failure as long as the communication path to the drive is not lost.

Figure 3 Data path port failover example configuration



1. Primary data path
2. Secondary data path
3. Host connection
4. HP Ultrium dual port Fibre Channel tape drive

Basic control path failover details

Library basic control path port failover (see Figure 4 (page 10)) may be configured with one drive hosting the active logical link to the library controller and a second drive configured as the passive logical link to the library controller. The library connections share physical links with the drives but the library has its own identity on the SAN and will show up as a unique device. Unlike the typical bridged library controller configuration shown in "Typical bridged library controller connection" (page 7), basic control path failover uses a Fibre Channel technology called NPIV, which allows the library to show up on the SAN as a new device with its own worldwide name instead of showing up as a logical unit behind the tape drive. Connecting as an independent device makes it possible to change the library controller SAN connection without affecting the drive connection.

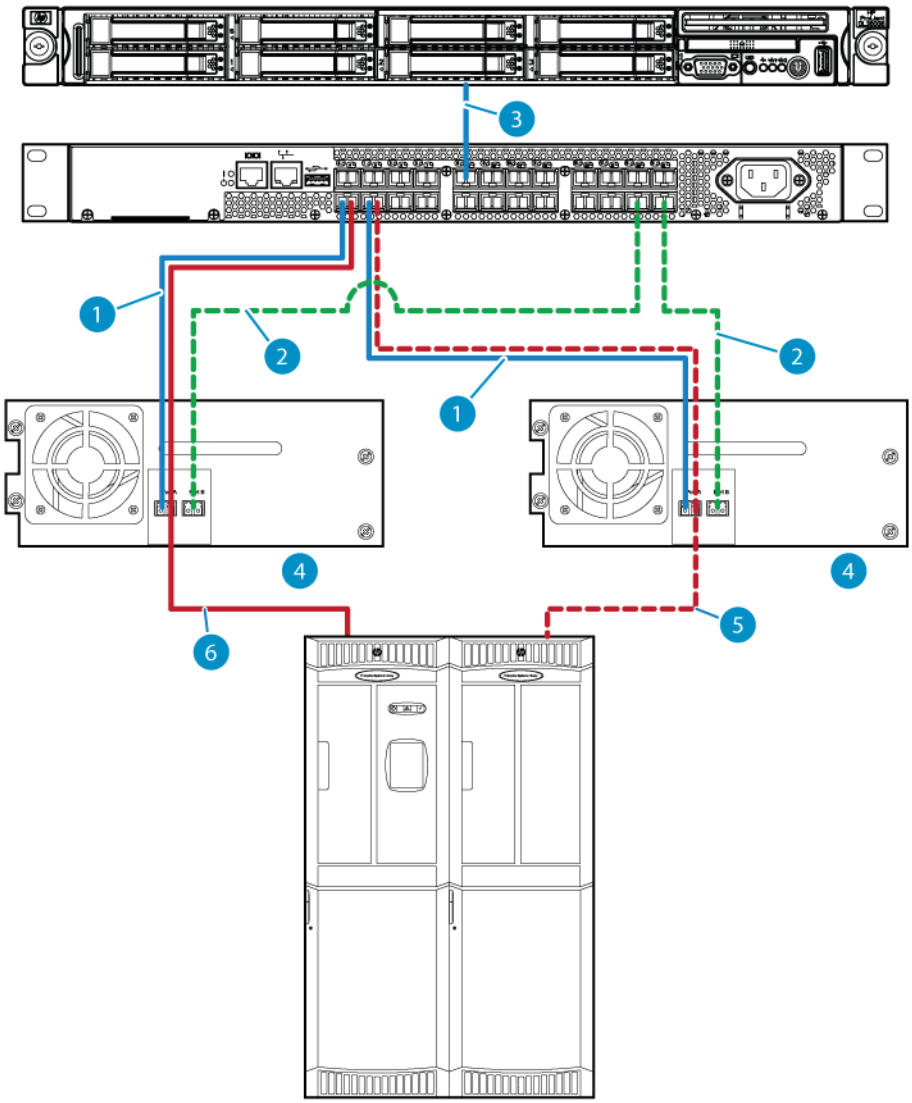
If basic data path port failover is also configured, the library control path follows the data path on single link failures.

With basic control path failover, the ESL G3 library monitors the drive that is hosting the library controller and the ports on the drive. The library receives notification from the drive of any interface change events and can quickly detect whether that change indicates a fault. The library also monitors the drive and can detect when a drive has been removed or otherwise becomes inaccessible. Upon detecting a fault that would cause loss of communication with the library controller, the library automatically moves the library control path identity (world wide names) and all settings (such as reservations and prevent/allow settings) over to the alternate control path drive and activates the control path on the alternate drive. When properly configured, the change is minimally disruptive to the host and does not require any configuration changes on the host or in the backup application.

NOTE: The MSL libraries monitor drive removal events and if the active control path drive is removed, the library will automatically move the control path to the standby drive. However, if the control path drive is not removed but SAN connectively is lost, the administrator might need to use the library remote management interface to move the control path to the standby drive.

If no library commands are sent while the port is being reconfigured, the port change happens with virtually no disruption to the SAN. Commands sent while the port is being reconfigured might be completed but cannot report the command status to the application so the application will receive an error. Applications that retry commands are able to use the library following reconfiguration of the port. Applications that do not retry can be restarted remotely without making any hardware configuration changes.

Figure 4 Control path port failover example configuration



1. Primary data path
2. Standby data path
3. Host connection
4. HP Ultrium Dual Port Fibre Channel Tape Drives
5. Passive logical link to switch shares physical link on drive #2
6. Active logical link to switch shares physical link on drive #1

Technology for basic control path failover

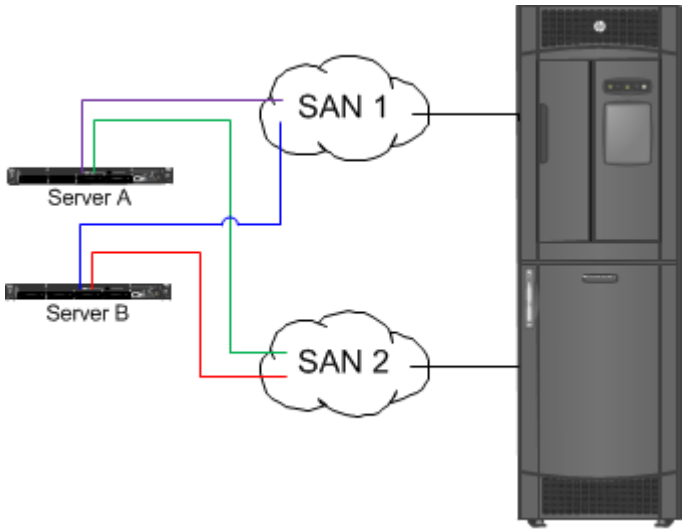
HP LTO-5 and LTO-6 Fibre Channel tape drives use a technology called N-Port Identifier Virtualization (NPIV) which is defined as part of the Fibre Channel standards maintained by the INCITS/T11 working group (see clause 6) in the FC-LS-2 specification. NPIV allows a single physical port to connect to a Fibre Channel switch multiple times using multiple node and port names.

Advanced path failover

Advanced path failover uses capabilities in the LTO-6 tape drives and the libraries in which they are installed, combined with software drivers running on a host system to provide path failover when multiple paths are available to a tape drive or to a library controller. Advanced path failover is a licensed feature.

An example multi-path configuration is shown in Figure 5 (page 11).

Figure 5 Example multi-path configuration



In this example configuration, two different servers designated as “Server A” and “Server B” each have two different host interface ports that are connected to two different SANs. Each SAN is connected to the tape library. The connection between the library and the SAN in this example is a bundle of connections that contains a connection to one port on each drive in the library. All of the drives in the library have two ports with one port connected into SAN 1 and the second port connected into SAN 2. The library in this example has two different drives which are both configured to provide a library control path. Each drive that is configured to provide a library control path will connect to the SAN as two devices, a tape drive and a library controller, at two different SCSI logical units.

The list of paths available at one of the servers is shown in “Example path list” (page 12). In this table, the SAN that contains the path is listed in the first column and the following columns show what device is being addressed (for example, the SCSI logical unit), the port on the drive that is being accessed, an example SCSI address, and the worldwide identifier (such as a Fibre Channel worldwide node name) of the addressed logical unit. The unique portion of the worldwide identifier is highlighted.

Table 1 Example path list

SAN	Addressed Logical Unit	Port	Example SCSI address	Example Logical Unit Worldwide Identifier
1	Tape drive 1	Port A	ID 1 LUN 0	50:01:10:a0:00:00:00:**01**
1	Library Controller	Port A	ID 1 LUN 1	50:01:10:a0:00:00:00:**02**
2	Tape drive 1	Port B	ID 2 LUN 0	50:01:10:a0:00:00:00:**01**
2	Library Controller	Port B	ID 2 LUN 1	50:01:10:a0:00:00:00:**02**
1	Tape drive 2	Port A	ID 3 LUN 0	50:01:10:a0:00:00:00:**03**
1	Library Controller	Port A	ID 3 LUN 1	50:01:10:a0:00:00:00:**02**
2	Tape drive 2	Port B	ID 4 LUN 0	50:01:10:a0:00:00:00:**03**
2	Library Controller	Port B	ID 4 LUN 1	50:01:10:a0:00:00:00:**02**

In this example the server is able to evaluate the worldwide identifiers to determine that there are two paths to each of two different tape drives and four paths to a library controller.

In a typical multi-path configuration all of the paths for each device are available to the application which must resolve redundant paths and choose a preferred path.

When advanced path failover drivers are installed on the server, the drivers will query each device for support of advanced path failover and if the device supports advanced path failover, the drivers will select a preferred path for each device and establish a connection using the preferred path. Only one path will be visible to the application.

Driver operation during device open

When an application requests that a connection to a device be opened, the failover driver will connect to the selected device, and if that device supports advanced path failover, will negotiate for a connection (a nexus using INCITS/T10 standards terminology) to that device. Computers running Windows will open a connection to each device when the server is booted. Computers running HP-UX and Linux don't open a connection to the device until an application opens the device for reading and/or writing.

Each device supports up to 32 simultaneous failover connections. If a failover connection is available, a connection between the host driver and the device is created. If no failover connection is available, the connection that has been idle for the longest time is closed and then the new connection is created. The server connected to the terminated idle session is notified that the failover connection has been terminated and the advanced path failover driver on that system will automatically create a new connection the next time a command is sent to the device.

NOTE: Systems using advanced path failover should be designed with 32 or fewer active hosts per device for optimal performance. Hosts should be configured so that they do not send unnecessary polling commands to the device.

Opening a connection to a library control path

In a system configured for advanced path failover at least two tape drives should be configured to provide a path to the library controller. For additional redundancy, the ESL G3 library allows configuring more than one standby control path drive. Some library state information is retained in the drive hosting the library controller so each server that requests a connection to the library controller is required to create a connection using a path through the same hosting drive. The library controller provides a method for the administrator to select the preferred control path drive. The advanced path failover driver will query each available control path drive to determine the preferred control path drive (called the 'active' control path drive) before requesting a connection.

Driver operation during normal communications

The advanced path failover driver passes commands through without any command translation and with minimal additional processing in normal operation to retain the maximum possible performance. During normal communication the advanced path failover driver does not introduce additional commands that would cause delays (for example, commands to determine position) during reading and writing.

Path failure detection

The advanced path failover driver uses notifications from the SCSI subsystem that report link failures immediately following a path failure, which allows recovery to happen as quickly as possible so most recoveries complete before the standard command timeout. In some operating systems the path failure notification is received immediately after the failure and the failover drivers are able to perform path failure recovery even if there are no outstanding commands. In other operating systems the advanced path failover drivers are only notified of a path failure when a command is transmitted over that path.

Path failure recovery

Following detection of a path failure the advanced path failover driver queries a path verification feature in the LTO tape drive to test paths until a valid path to the device is detected. The path verification feature allows rapid detection of failed and valid paths without waiting for long timeouts or hardware specific notifications. After a new path has been identified the advanced path failover device driver will send a command to the device using the new path to notify the device that a path has failed, indicate which connection has failed, and to provide state information. Upon receipt of a notification that the path has changed, the target device will automatically transfer all available settings and information from the failed connection to the new connection and use the state information provided in that change notification to synchronize the target state with the device driver state then will notify that device driver that it has successfully synchronized state. Synchronization of the state includes any physical position changes necessary to position the tape in the correct logical position for that state.

After receiving notification that the state is synchronized between the advanced path failover device driver and the target device, the advanced path failover device driver can take the steps necessary to recover any commands that were outstanding at the time of the failure. For most commands recovery is accomplished by resending the original command.

Notifying the target device of the path change and performing the state synchronization in the target device removes complex state recovery algorithms from the driver and removes the risk of incorrect tape positioning during state recovery, resulting in a higher performance, lower complexity, and less risky path failover method than a traditional driver where all recovery is performed by the driver.

Active and passive control path drives

The SCSI connection to libraries using advanced path failover is through the physical link in a tape drive. Libraries that support advanced path failover will configure two different tape drives so that they present a library control path (Medium Changer) device and forward commands addressed to the library control path device on to the changer controller in the tape library. One of the tape drives will be configured as an “active” control path drive, which means that the library control device presented by this tape drive will accept commands such as MOVE MEDIUM for the changer device. One of the tape drives will be configured as a “passive” control path drive, which means that the library control device presented by this tape drive will accept device discovery commands such as INQUIRY, but will reject commands such as MOVE MEDIUM. The advanced path failover drivers will automatically select an “active” path to the library and will automatically reconfigure which drive is the active control path drive when reconfiguration is necessary during failover. The

tape library user interface will show which control path drive is the current active control path drive.

Library controller path failure recovery

In most cases the library controller path failure recovery is the same as the tape drive path failure recovery. If all paths to the drive hosting the library controller have failed, the advanced path failover driver is capable of opening a connection to the library controller through another tape drive.

The library control path is hosted by a tape drive, which maintains some state information on behalf of the library controller. The state information maintained by the tape drive includes reservations, media removal restrictions, and may contain special mode settings. Any time that the library state changes, the library notifies the advanced path failover driver that a state change has occurred and then the advanced path failover driver retrieves a cache of the state information.

When all paths to the drive that was hosting the library control path fail, the advanced path failover driver will connect to a different drive and configure the new drive as the preferred control path drive. After activating a passive control path drive the path failover driver will download the state information from the previous control path drive. The newly activated control path drive will notify the library controller that the preferred control path drive has changed and the library will disable the previous control path drive. Any servers still connected to the original control path drive are notified that the preferred control path drive has changed and the advanced path failover driver on those servers will automatically change the preferred path for future commands to the new preferred control path drive.

2 Enabling basic path failover

To successfully enable basic path failover, complete the following:

- Verify that the switch and host prerequisites are met. See "Preparing the switches and hosts for failover" (page 18).
- Verify that the tape drive and library prerequisites are met and then configure failover for your library:
  - "Configuring failover for the HP StoreEver ESL G3 Tape Libraries" (page 20)
  - "Configuring failover for HP StoreEver MSL6840 Tape Libraries" (page 27)
  - "Configuring failover for other HP StoreEver MSL Tape Libraries" (page 31)

3 Installing advanced path failover

To successfully install advanced path failover, complete the following:

- Prepare the SAN. See "Preparing the SAN" (page 16).
- Prepare the library. See "Preparing the library" (page 16).
- Prepare the host. See "Preparing the host" (page 17).

Preparing the SAN

To prepare the SAN, review the following:

- "Minimize host access" (page 16)
- "Configure redundant connections" (page 16).
- "Review the SAN design guidelines" (page 16)
- Verify that the switch prerequisites are met. See "Preparing the switches and hosts for failover" (page 18).

Minimize host access

Advanced path failover is supported for a maximum of 32 hosts connected to each tape drive or tape library. Each host should have two to four ports for a total of 64 to 128 connections to each tape drive or tape library.

Connecting more than 32 hosts may cause performance degradation if extra hosts are attempting to access the drives or library while another host is using the device.

Use switch zoning or Secure Manager to configure the SAN or library so that only hosts that need to access the devices are able to connect.

Configure redundant connections

Each tape drive in the library has two ports. For best results the drives should be connected to two different SANs, with all of the first ports connected to one SAN and all of the second ports connected to another SAN. The total number of SAN switch ports required for connecting the library is twice the number of tape drives installed in the library.

If both ports for a tape drive are connected to the same switch, fault tolerance is reduced as a single switch failure will cause loss of connectivity. If only one switch is available, that switch must be zoned to create two logical SANs.

Review the SAN design guidelines

The general SAN design guidelines for tape are documented at: http://www.hp.com/go/ebs.

Preparing the library

Advanced path failover is a licensed feature with Control Path Failover and Data Path Failover licensed separately. Licenses for all failover solutions are also available as a high-availability bundle. Control Path Failover provides path fault tolerance for the robot controller and Data Path Failover provides fault tolerance for the tape drive data path. Each feature is licensed once for each tape library and then enabled separately for every partition and tape drive. The settings may be different for different partitions and drives depending on the user requirements.

When advanced path failover is enabled for either the control path or the data path, the library partition and/or tape drives with advanced path failover enabled can only be used by hosts with the advanced path failover driver installed. If the tape drive or tape library detects that advanced path failover is enabled and a request to access the media or move media is received from a host

that is not using an advanced path failover driver, the drive or library will reject the command with an additional sense code of 82h/93h, FAILOVER SESSION SEQUENCE ERROR. That error code should only be reported to an application if the advanced path failover drivers are not installed on that host.

In a mixed environment where some hosts have advanced path failover drivers installed and some hosts do not, the library should be partitioned so that one partition is accessed by hosts that are using advanced path failover and the second partition is accessed by hosts that are not using advanced path failover. In some cases a mix of host operating systems might be used with a single partition. For example a Windows host might be running the library control agent and another operating system is performing backups. In that configuration advanced control path failover could be enabled and the advanced path failover driver installed on the library control host but the drives may be configured without path failover.

If a single ESL G3 library needs to serve both hosts that have advanced path failover drivers installed and hosts without advanced path failover drivers, the ESL G3 library can be configured with pools of drives where all of the hosts with advanced path failover drivers use one pool of drives and advanced data path failover is enabled on those drives. At the same time, a second pool of drives in the same partition either has basic data path failover enabled or no data path failover enabled. The second pool of drives is accessed by the hosts that do not have advanced path failover drivers. The MSL6480 does not support mixing basic and advanced path failover, so the drives connected to hosts without advanced path failover drivers must be configured without path failover enabled.

For instructions on installing advanced path failover for your library, see:

- ESL G3: "Configuring failover for the HP StoreEver ESL G3 Tape Libraries" (page 20)
- MSL6480: "Configuring failover for HP StoreEver MSL6840 Tape Libraries" (page 27)

Preparing the host

Hosts used with advanced path failover must be configured with two different data paths and should be configured with two different HBAs. For supported HBAs see the compatibility matrix on the HP Archive, Backup and Recovery Solutions website: http://www.hp.com/go/ebs.

For the highest level of fault protection, connect two different HBAs in the host to two different SANs. This configuration provides full fault tolerance from both an HBA failure and a SAN switch failure. If a single HBA is used, an HBA failure might result in loss of connection.

The advanced path failover driver for Windows selects the first path it discovers. If you want the driver to select a particular SAN path, configure the host so that the HBA for your preferred path is installed in the position with the lowest numbered bus location. Refer to your server documentation for bus location information. The Linux path failover driver and the HP-UX operating system have built-in load balancing and when a tape drive is opened the operating system selects the best path based on the current path loading.

The Linux advanced path failover driver has a command for requesting a partition path to be preferred. That setting will only persist until the next reboot because the hardware configuration can change when the server reboots. The driver is unable to detect whether the hardware is the same as the previous boot so the preferred setting is not retained across reboots. You can use a boot time script to set the preferred path at each boot when the hardware configuration is stable. For persistent path binding, use Linux udev rules to create persistent paths.

After the host has been configured and booted, install the drivers necessary for the host operating system.

- "Installing and using Windows advanced path failover drivers" (page 35)
- "Installing and using Linux advanced path failover drivers" (page 43)
- "Installing and using HP-UX advanced path failover drivers" (page 48)

4 Preparing the switches and hosts for failover

Prerequisites for using basic data and control path failover:

- The library drive FC ports must be attached to a Fibre Channel SAN that supports NPIV and NPIV must be enabled. LTO-5 and LTO-6 drives need an 8G connection with the fill word set to arb(ff). With 4G connections, set the fill word to idle.
- The switch is running a supported version of software. For a list of supported software, see the compatibility matrix on the HP website: http://www.hp.com/go/ebs
- The drive port FC topology must be in Fabric mode and the switch side must be set to F-port or Auto Sense.
- The host Fibre Channel port must have a physical path to both the first port and secondary (passive) port on the Fibre Channel drive.
- For basic data path failover with port zoning, the host Fibre Channel port and both ports on the drive need to be within the same zone for failover to work.
- For basic data path failover with World Wide Port Name zoning, the host Fibre Channel World Wide Port Name and a single first port on the drive need to be in the zone.
- For basic control path failover with port zoning the host Fibre Channel ports and the ports on both the active and secondary drive chosen for basic control path failover will need to be in the same zone.
- For basic control path failover with World Wide Port Name zoning the host Fibre Channel World Wide Port Name and basic control path failover World Wide Port Name assigned to the library must be in the same zone. The Library World Wide Port Name is not the same as the World Wide Port Name of the drive that is hosting the library.
- Hosts connecting to the library may need to be rebooted if the operating system does not support dynamic device detection.
- Applications on hosts may need to be reconfigured to recognize the new library world wide name.

Prerequisites for using advanced data and control path failover:

- With LTO-5 and LTO-6 drives with an 8G connection, set the fill word set to arb(ff). With 4G connections, set the fill word to idle.
- The switch is running a supported version of software. For a list of supported software, see the compatibility matrix on the HP website: http://www.hp.com/go/ebs
- For advanced data path failover, the host must have a physical path to both the first port and secondary port on the Fibre Channel drive. For full failover capabilities, the two drive ports should be connected to different switches and the host Fibre Channel ports should also be connected to the same two switches.
- All drive ports must be zoned in the respective switches.

Hardware-specific requirements for basic failover

Brocade switches

Most recent firmware versions have NPIV enabled by default but it is configured per port and could have been disabled. Verify that NPIV is enabled.

For best reliability use firmware revisions v6.2.2f, v6.3.2d, v6.4.3e, v7.1.1c or newer, depending on the switch family. See the *Design Guide for Backup and Archive* for current supported revisions at www.hp.com/go/ebs).

To enable NPIV on a Brocade switch, navigate to port administration and execute an advance view.

Cisco switches

Some Cisco switches that support NPIV do not have NPIV enabled by default. The Cisco MDS 9148 may disable NPIV when power cycled.

To enable NPIV on a Cisco switch use **Cisco_Device_Manager > Admin > Feature_Control** or use the Cisco CLI commands show NPIV status and NPIV enable.

Hardware-specific requirements for advanced path failover

The NPIV settings are not needed for advanced path failover. For supported switch firmware versions, see the *Design Guide for Backup and Archive* on the HP website at http://www.hp.com/go/ebs.

B-Series switches

For best reliability use revision v7.1.1c, or newer. LTO-5 and later drives work best with 8G connections configured with arb(ff) type 3, which is done by using the `portcfgfillword` command to set the ports to use fill word type 3. The fill word for 4G connections should be set to idle.

C-Series switches

For best reliability use minimum revision 5.2(8)

H-Series switches

For best reliability use minimum revision v7.4.0.21.0.

5 Configuring failover for the HP StoreEver ESL G3 Tape Libraries

Configuring data path failover

When basic data path failover is enabled, the drive is presented on the first drive Fibre Channel port, by default, and the second Fibre Channel port is a passive port. If the primary port goes down, the library transfers various settings over to the passive port and then enables the failover port. When advanced path failover is enabled, the drive is presented to the host over both SANs and the host driver determines the active path.

Prerequisites for basic and advanced data path failover:

- The HP StoreEver ESL G3 Data Path Failover license must be installed on the library.
- The host must have a physical path to both the first port and secondary port on the FC drive.

Additional prerequisites for basic data path failover:

- Only LTO-5 and LTO-6 Fibre Channel tape drives support basic data path failover.
- The library must be attached to a Fibre Channel SAN that supports NPIV.
- The drive port Fibre Channel topology must be in Fabric mode.
- All paths to the Fibre Channel drive must be accessible from the same HBA and all of the devices need to be within the same zone.
- If Secure Manager is enabled, hosts that need access to the control path must be given robotics device access to the first Fibre Channel port on both the active control path drive and the standby control path drive.

Additional prerequisites for advanced data path failover.

- Only LTO-6 Fibre Channel tape drives support advanced data path failover.
- Host drivers need to be configured on all hosts. The hosts that do not have advanced path failover drivers will see the drives but will not be able to write, read, or send move commands. The advanced path failure drivers also support drives configured with basic path failover or without failover configured.
- If Secure Manager is enabled, hosts that need access to the control path must be given robotics device access to all Fibre Channel ports on both the active control path drive and the standby control path drive. The host will have two different worldwide names for the two different HBAs and each worldwide name may be granted access to all ports or one name may be granted access to the first Fibre Channel port and the second name may be granted access to the second Fibre Channel port.

NOTE: For increased fault tolerance, select two drives that have less common library infrastructure for the active and passive control path drives. For example, if you choose drive 1 as the active drive, choose a passive drive in another cluster or library module.

Enabling data path failover

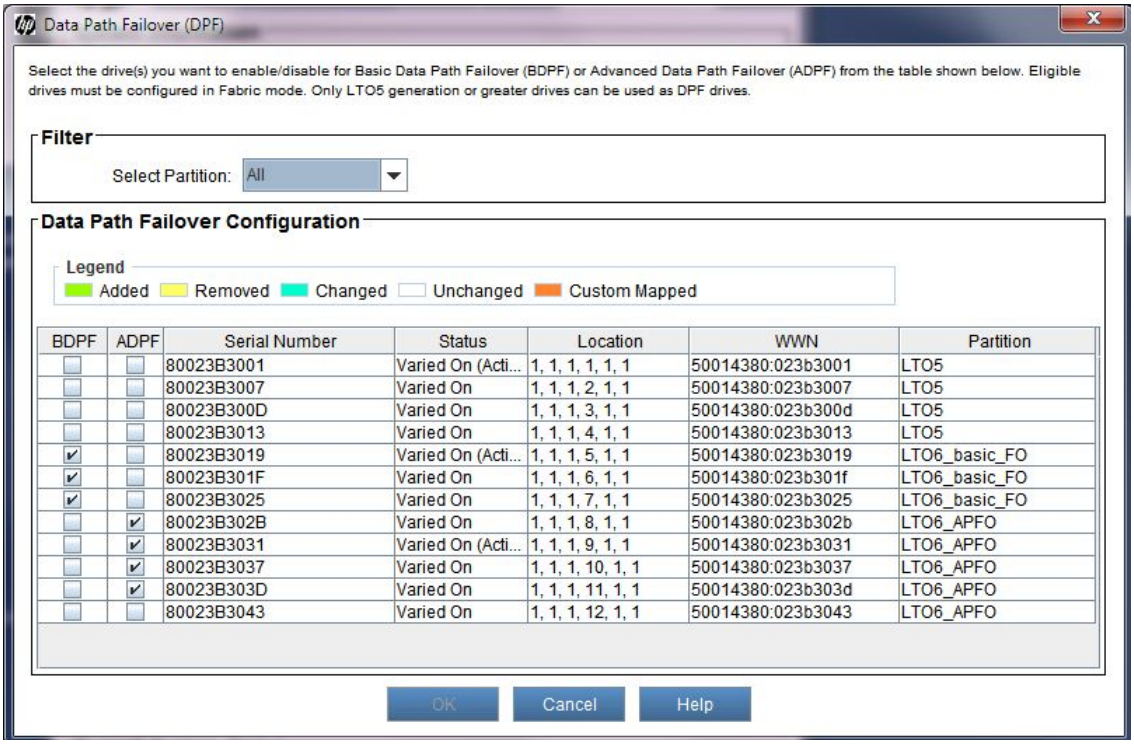
To enable data path failover:

1. Log into the Management Console as a user with Administrator privileges.
2. Select the **Physical** managed view.
3. Select **Setup** > **Partitions** > **Data Path Failover**.
4. The **Data Path Failover (DPF)** dialog appears and displays all LTO-5 and LTO-6 drives. You can filter the list by partition. Select the drives for which you want to enable advanced data path failover (ADPF) or basic data path failover (BDPF), and then click **OK**.

NOTE: Any drives that belong to an access group and have hosts mapped to the second port are considered to be custom mapped. BDPF cannot be enabled on these drives until the custom mapping is removed.

Advanced Data Path Failover can only be enabled on LTO-6 drives. Basic Data Path Failover can be enabled on both LTO-5 and LTO-6 drives.

See the *HP StoreEver Enterprise Systems Library (ESL) G3 Tape Library User Guide* for more information on modifying partitions.



5. Wait for the configuration change to complete.

Verifying data path failover

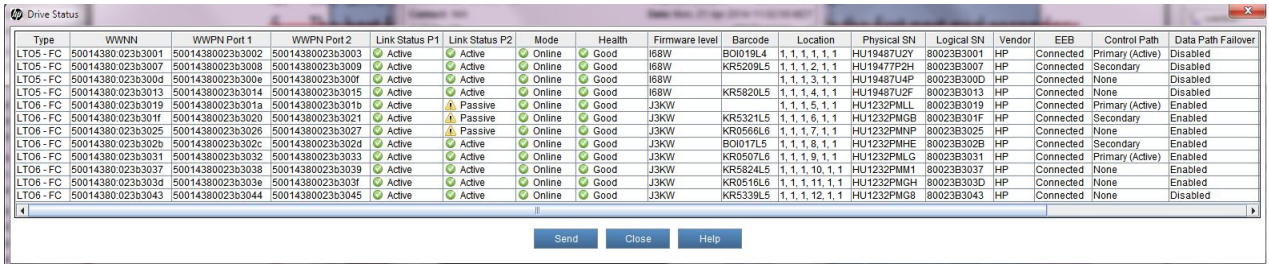
To verify that basic data path failover is configured, navigate to **Monitor→Drives** to launch the **Drive Status** dialog.

When basic data path failover is enabled for a drive:

- The **Link Status** for one of the ports is listed as **Active**.
- The **Link Status** for the second drive is listed as **Passive**, meaning that this is the failover port.
- The **Data Path Failover** column displays **Enabled**.

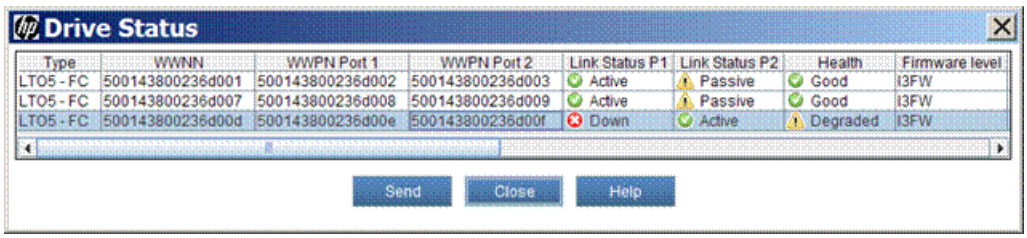
When advanced data path failover is enabled for a drive:

- The **Link Status** for both ports is listed as **Active**.
- The **Data Path Failover** column displays **Enabled**.



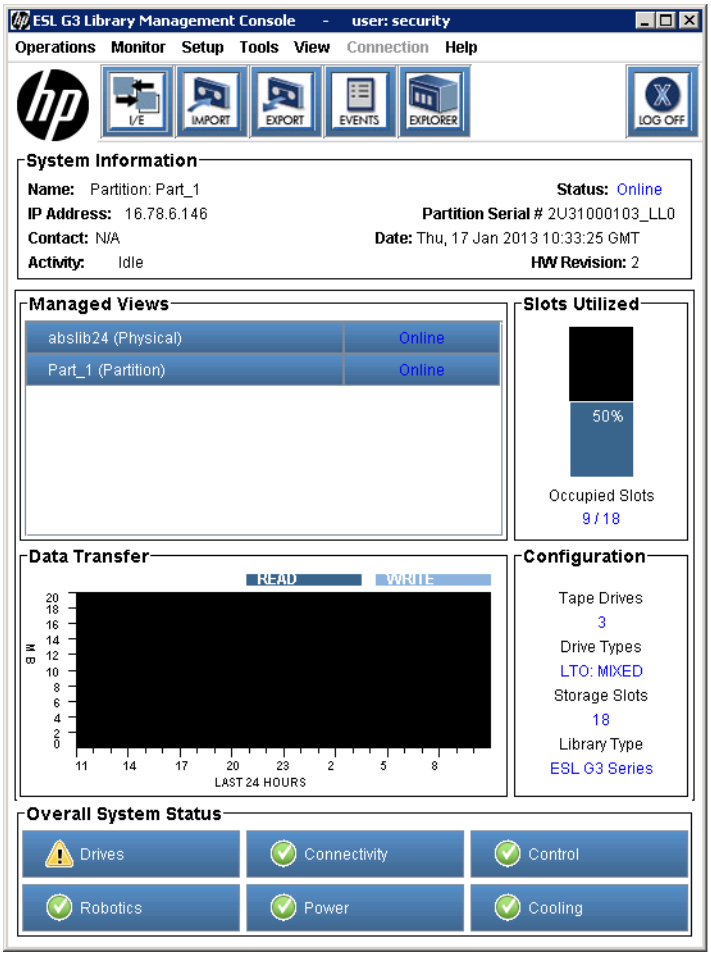
To verify that basic or advanced data path failover is working:

1. From the Fibre Channel switch's management console, down the main Fibre Channel port to a drive.
2. From the host computers confirm that the drive is still accessible. After confirming that the drive is still accessible the host logs should show a failover event.
3. To verify that failover occurred, navigate to **Monitor→Drives** to launch the **Drive Status** dialog. The link status for the first port is **Down**, and the link status for the second port is **Active** as shown below.



Diagnosing basic data path failover

When a drive failover occurs the Drives subsystem has a `Warning` state, which is displayed in the **Overall System Status** section of the Management Console.



Click **Drives** to display the **Event List**, and then select the event and click **Details** to see more information about the failover event. The **Repair** tab provides detailed instructions on how to troubleshoot and fix the problem.

Disabling data path failover

To disable data path failover:

1. Log into the Management Console as a user with Administrator privileges.
2. Select the Physical managed view.
3. Select **Setup**→**Partitions**→**Data Path Failover**.
4. Uncheck the drive for which you want to disable ADPF or BDPF, and then click **OK**.
5. Wait for the configuration change to complete.
6. Verify the configuration change by selecting **Monitor**→**Drives**. **Data Path Failover** is shown as **Disabled**.

After advanced path failover is disabled, multiple paths to each device will be presented to the host. The advanced path failover driver supports devices with or without advanced path failover enabled so uninstalling the advanced path failover driver is not required when advanced path failover is disabled.

Configuring control path failover

When basic control path failover (BCPF) is enabled, the library is presented on the first drive Fibre Channel port. If basic *data path* failover is configured on the drive, the second Fibre Channel port will be one of the control path failover ports.

When advanced control path failover (ACPF) is enabled, the library is presented on all the Fibre Channel ports of all the drives configured to handle the library control path.

For both ACPF and BCPF, you must configure a secondary control path drive and the ports on that drive will be standby control path failover ports that can be activated in the event of complete loss of connection to the primary control path drive. Standby control path drive ports are still active data path ports and can be used for tape drive access even when the drive is configured as a passive control path drive.

If the active control path port goes down, the library transfers various settings to one of the passive ports and then either the library enables the control path failover port for basic path failover or the driver switches the active path for advanced path failover.

For prerequisites, see "Configuring data path failover" (page 20).

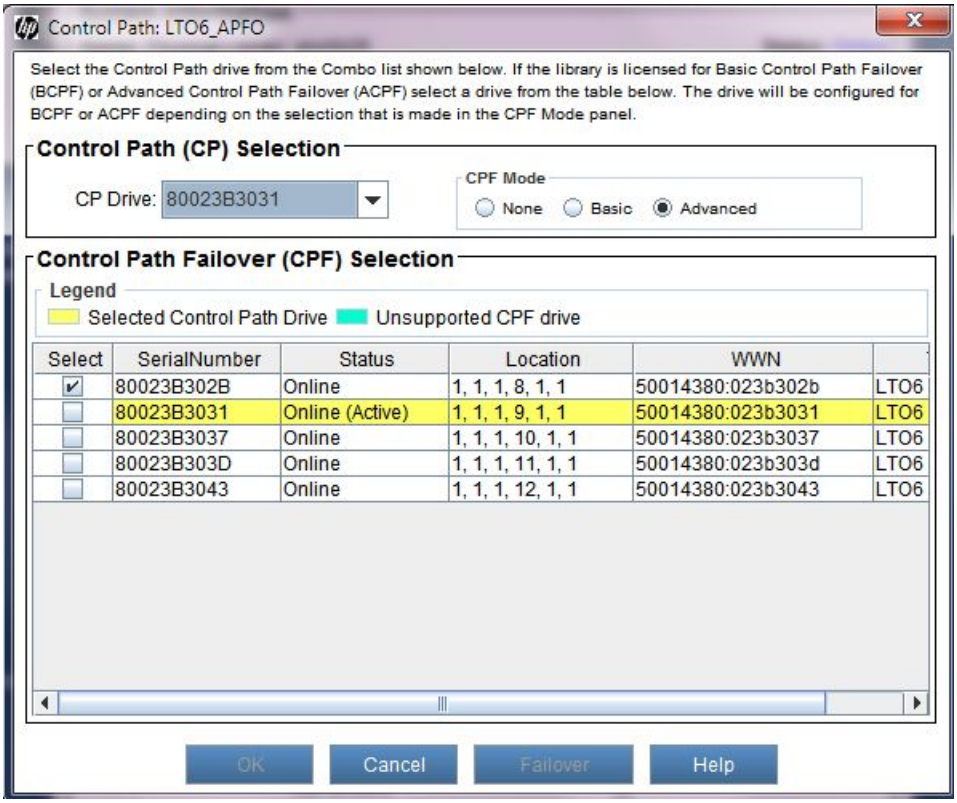
Enabling control path failover

To select a partition and configure control path failover:

1. Log on as administrator.
2. From the main console, select **Setup→Partitions→Control Path**.
3. When prompted, select the partition you would like to configure. Click **OK**.

   The Control Path dialog box appears.
4. In the Control Path (CP) Selection pane, select the primary control path drive.
5. Select the drive you wish to configure as the standby control path failover drive from the Control Path Failover (CPF) Selection list.

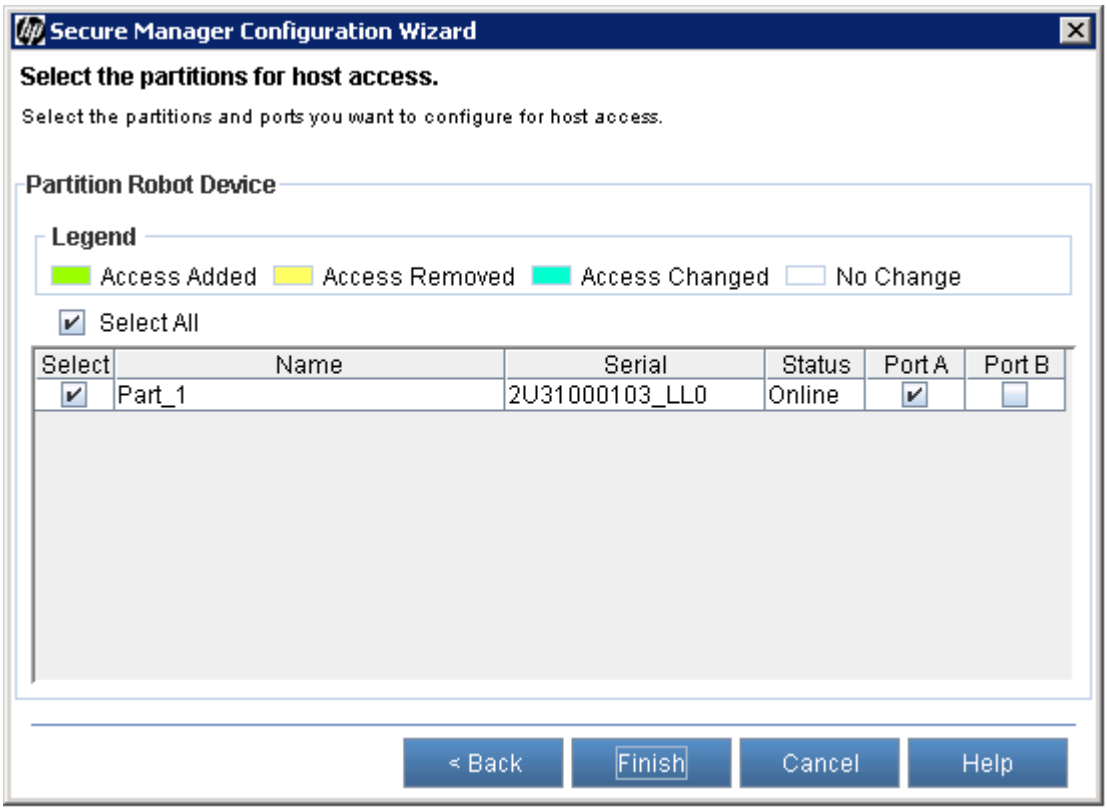
   NOTE: LTO-4 drives do not support failover. LTO-5 and LTO-6 drives support Basic Path Failover, but only LTO-6 drives are supported for advanced path failover.
6. Under **CPF Mode**, select either **Basic** or **Advanced** path failover.
7. Click **OK**.



Configuration requirements after enabling control path failure

Library configuration

If Secure Manager is enabled, hosts that have been granted access to the control path device must be mapped to the first Fibre Channel port of the drive for basic control path failover and must be granted access to both ports for advanced path failover.

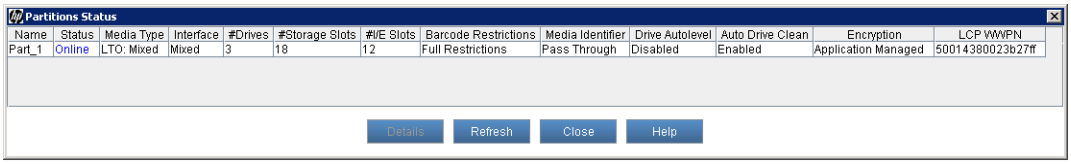


SAN configuration

When basic control path failover is enabled, the library is no longer presented as a logical unit behind the tape drive and is assigned a new Fibre Channel node name which needs to be zoned in the same zone as the primary and secondary CP drives. For additional SAN requirements, see "Preparing the switches and hosts for failover" (page 18).

After configuring the basic control path failover parameters, you might need to make additional changes:

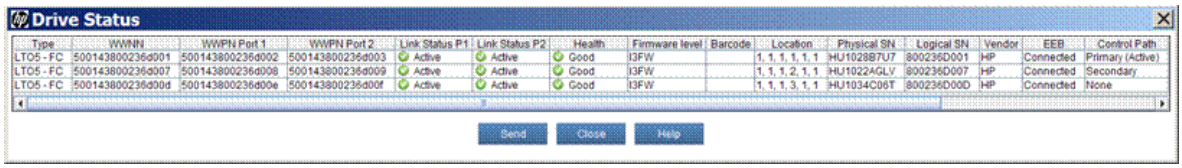
- To find the world wide name assigned to the library controller, use the **Monitor→Partitions** menu to see the **Partitions Status** dialog. The world wide name for the library controller is shown in the LCP WWPN column.



- Hosts connecting to the library may need to be rebooted if the operating system does not support dynamic device detection.
- Applications on hosts may need to be reconfigured to recognize the new library world wide name.

Verifying control path failover

Before testing control path failover, verify that the configuration is correct in the **Drive Status** dialog, which is accessed from the **Monitor→Drives** menu. The **Control Path** column identifies the primary and secondary control path drives. The drive currently hosting control path access is marked **Active**.

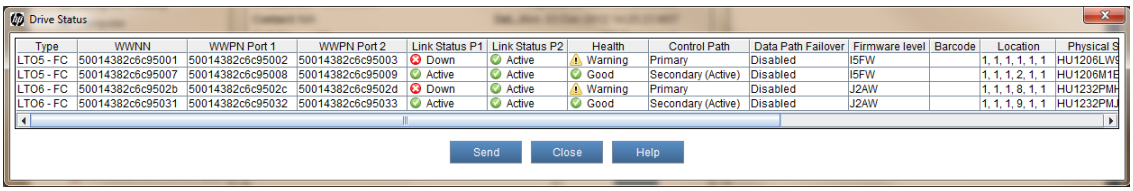


To test basic control path failover:

1. From the Physical managed view, select **Monitor→Partitions→Control Path**.
2. Select the partition with basic control path failover configured.
3. The Control Path dialog for the partition appears. Click **Failover**.
4. In the **Warning** dialog, click **Yes**.

NOTE: Since the control path is switching from the primary drive to the secondary drive, there could be a disruption in host traffic.

5. A progress dialog appears while the failover operation is in progress.
6. Select **Monitor→Drives** to launch the **Drive Status** dialog. The Secondary drive should now be the **Active** drive.



7. From the host computers confirm that the library is still accessible. After confirming that the library is still accessible, the host logs should show a failover event.

Disabling control path failover

To disable control path failover:

1. Log into the Management Console as a user with Administrator privileges.
2. Select the **Physical** managed view.
3. Select **Setup→Partitions→Control Path**.
4. The **Secure Manager Partitions** dialog appears and displays all available partitions.
5. Select the partition, and click **OK**.
6. The **Control Path** dialog appears with the command path drive highlighted in yellow and the failover drive selected. Un-select the failover drive, and click **OK**.
7. Click **Yes** in the **Warning** dialog to take the partition offline. Wait for the configuration change to complete. Once completed, the partition is automatically put online.

6 Configuring failover for HP StoreEver MSL6840 Tape Libraries

The MSL6480 Tape Library supports both basic and advanced path failover, though basic and advanced path failover cannot both be used in a partition at the same time. For example, advanced data path failover can be used with advanced control path failover or without control path failover, but not with basic control path failover.

Configuring control path failover

Control path failover is configured for each partition with the Expert Partition Wizard.

The requirements for using basic control path failover in a partition are:

- Two LTO-5 or two LTO-6 Fibre Channel drives of the same type (Ultrium 6250 half height; 3000 half height or Ultrium 3280 full height) are in the partition. Additional tape drives may be included in the partition but cannot be configured for failover.
- Advanced and basic failover may not be mixed within a partition.
- The Data Path Failover license has been added to the library.

The requirements for using advanced control path failover are:

- Two LTO-6 Fibre Channel drives are in the partition. SAS and earlier generation tape drives can be in the same partition, but cannot be configured for Advanced CPF.
- Basic data path failover is not enabled for the partition. Advanced and basic failover may not be mixed within a partition.
- The Control Path Failover license has been added to the library.

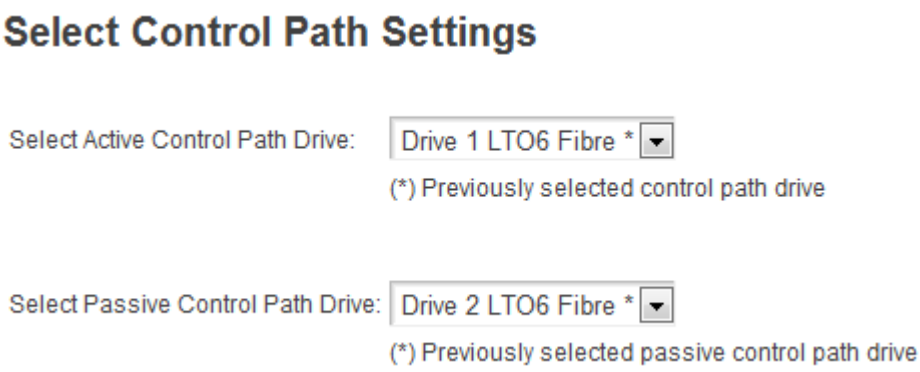
Enabling control path failover

Control path failover is enabled with the Expert Partition Wizard. From the **Configuration** area, click **Expert Wizard** in the **Partitions** menu to start the wizard. Select the type of failover for the partition from the **Select Control Path Failover Settings** screen as shown in Figure 6 (page 27).

Figure 6 Selecting the control path failover type

Figure 7 (page 28) shows the **Select Control Path** screen of the wizard. Select the active and passive control path drives. In the example shown, drive 1 is set as the primary path and drive 2 is set as the secondary path.

Figure 7 Selecting the basic control path failover settings



Configuration requirements after enabling basic control path failure

When basic control path failover is enabled, the library is no longer presented as a logical unit behind the tape drive and is assigned a new Fibre Channel node name. You can find the new world wide node name on the **Status > Library Status** screen.

Verifying control path failover

Basic control path failover

After enabling control path failover, modify switch zoning, if necessary, to enable host access to the library.

To verify basic control path failover, you can force a failover from the **Drives > Manual Control Path Failover** screen and verify that the control path has moved to the passive drive.

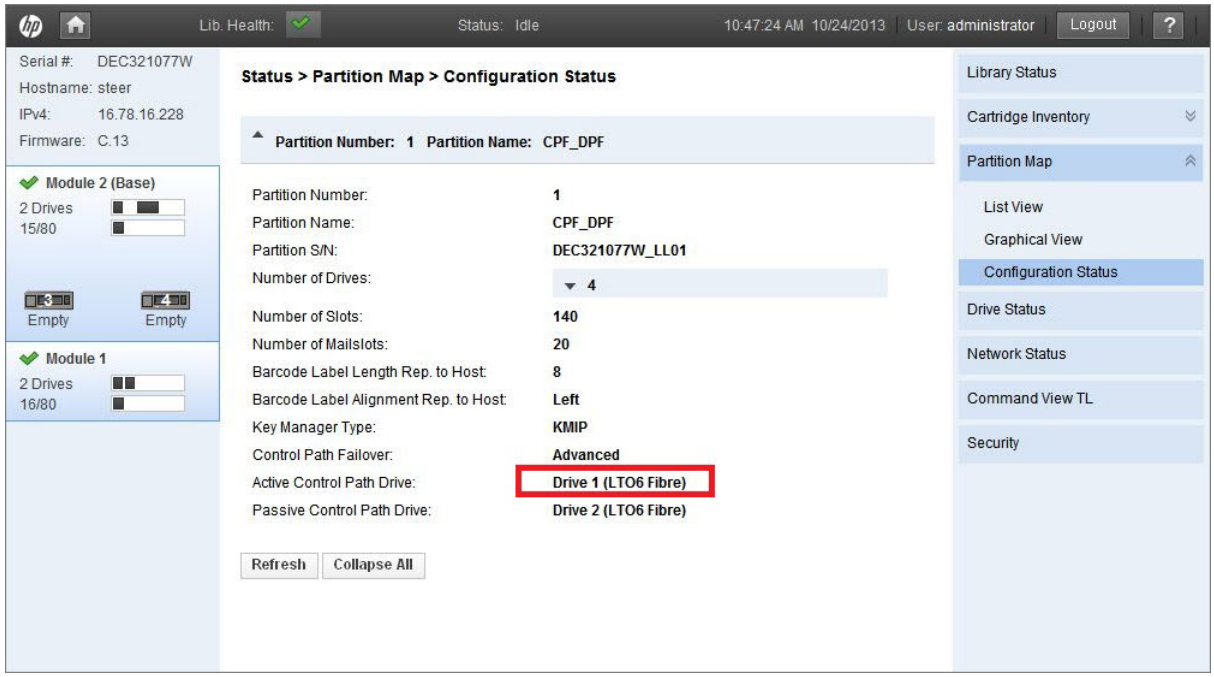
NOTE: There is always a library logical unit number hosted by a drive so the (LUN) indicator does not change when basic control path failover is enabled. The library is presented as logical unit number zero on its own world wide node name when basic control path failover is enabled and is presented as logical unit number one on the drive world wide node name when basic control path failover is not enabled.

Advanced control path failover

To verify advanced control path failover, you will need to power off the control path drive to create a failover event. You can find the active control path drive for a partition from the **Status > Partition Map > Configuration Status** screen, shown in "Status of the Partitions Configuration to verify basic control path failover" (page 29).

To cause a failover event, power off the active control path drive from the **Configuration > Drives > Settings** screen and then verify that the partition still has access to the host.

Figure 8 Status of the Partitions Configuration to verify basic control path failover



After verifying library connectivity using each of the library control paths, the library control path can be moved back to the original drive if needed by power cycling the alternate control path drive.

Configuring data path failover

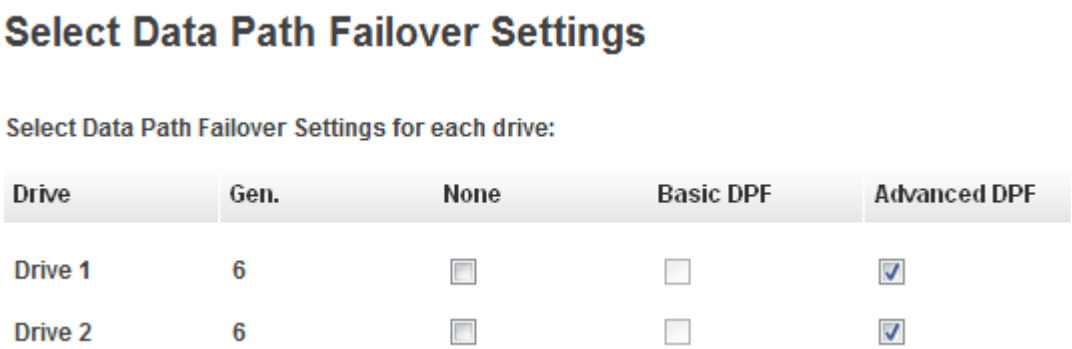
Basic and advanced data path failover can be used with the drive ports configured in loop mode or fabric mode. For best results and compatibility with basic control path failover, HP recommends that the drive ports be configured in fabric mode and connected to an FC switch.

Enabling data path failover

Data path failover is configured with the Expert Partition Wizard. From the **Configuration** area, click **Expert Wizard** in the **Partitions** menu to start the wizard. Select the type of data path failover for each tape drive in the partition from the **Select Data Path Failover Settings** screen.

For example, Figure 9 (page 29) shows advanced data path failover enabled for drives 1 and 2. In this case, Advanced DPF was pre-set by the wizard because Advanced CPF is configured for the partition. Because a partition cannot use a mixture of basic and advanced failover, the wizard will not allow Basic DPF to be selected in this case.

Figure 9 Enabling data path failover



Verifying data path failover

After data path failover is enabled:

1. Navigate to the **Status > Drive Status** screen, expanding the section for the drive to see the details.
2. Expand the section for each drive to see the details. The **Data Path Failover** field will show the type of data path failover configured.

   Verify that the interface status for both ports is **Login complete**.
3. From the host, verify connectivity to the drive.

7 Configuring failover for other HP StoreEver MSL Tape Libraries

The HP StoreEver MSL2024, MSL4048, MSL8048, and MSL8096 Tape Libraries with dual-port LTO-5 or LTO-6 FC tape drives support basic data path failover.

The HP StoreEver MSL2024, MSL4048, MSL8048, and MSL8096 Tape Libraries with multiple LTO-5 or LTO-6 FC tape drives support basic control path failover.

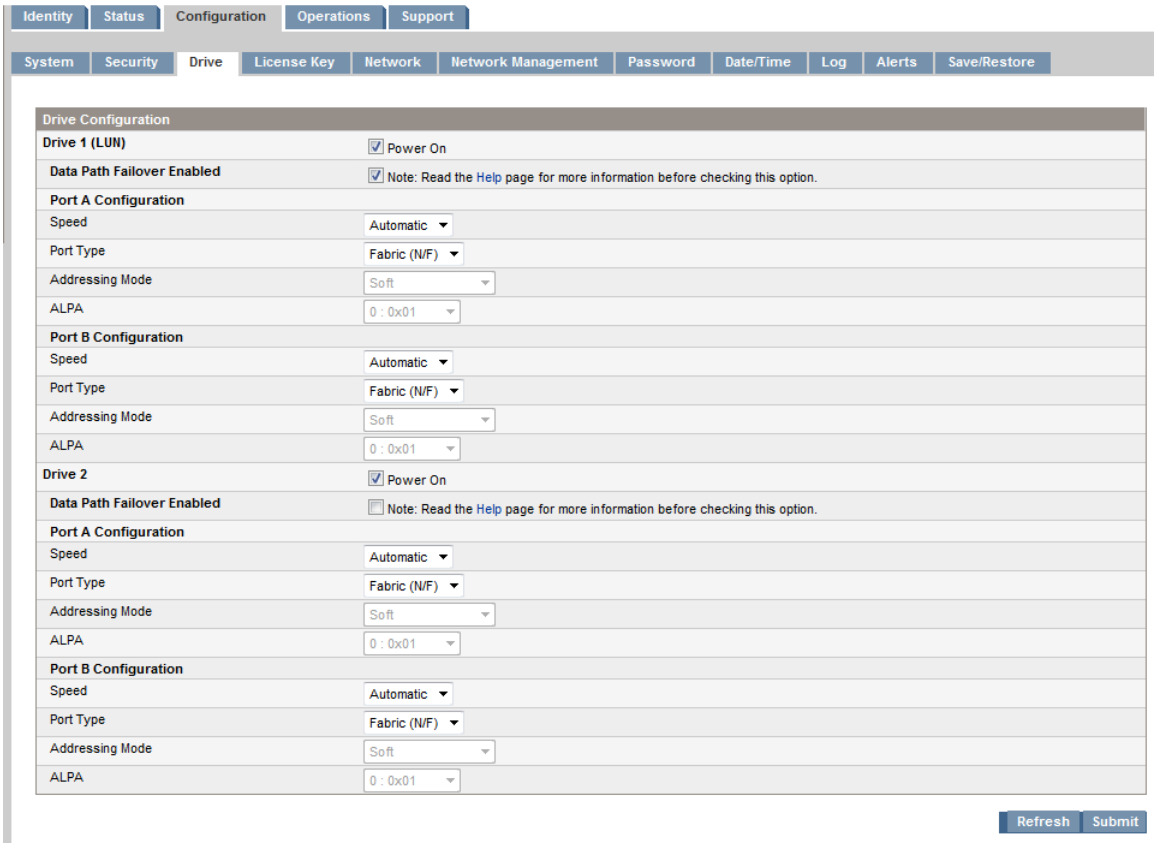
Configuring data path port failover

Enabling data path port failover

For best results and compatibility with basic control path failover HP recommends that the drive ports be configured in fabric mode and connected to a switch.

Basic data path failover is configured for each drive using the drive configuration options in the library network management interface. "Enabling data path port failover" (page 31) shows the drive configuration options in the library network management interface. In this example data path port failover is enabled for drive 1 but is not enabled for drive 2. Note that in this example control path port failover is also enabled. When control path port failover is enabled the port type is required to be fabric so the port type selections are disabled.

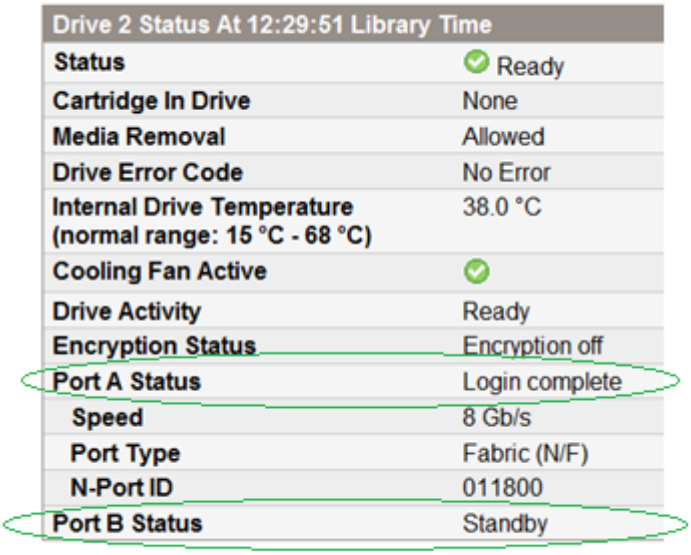
Figure 10 Enabling data path port failover



Verifying data path port failover

After data path port failover is enabled, verify the configuration in the **Drive: Status** screen, as shown in Figure 11 (page 32).

Figure 11 Standby and active ports



After verifying that the configuration change was successful, verify that the hosts with access to the tape drive are still able to communicate with the drive.

After verifying host access via the initial path, force a data path port failover by disconnecting the cable from the active port on the drive or using an FC switch management interface to down the port connected to the tape drive.

The drive status display shows which drive port is active and which port is in standby. After disconnecting the cable from the active port verify that the library network management page port status shows that the active port has changed. Reconnect the disconnected port and verify that it shows as **Standby**. Verify that each host still has access to the tape drive.

If a particular port is the preferred active port and it is configured as **Standby** you can force selection of a particular port as the active port by disconnecting the cable from the other port.

Configuring basic control path failover

Enabling control path port failover on the library

The HP StoreEver MSL Tape Libraries only support basic control path failover when used in a Fibre Channel SAN and connected as fabric devices. The minimum configuration is:

- A library or partition within a library with two LTO-5 or two LTO-6 Fibre Channel drives of the same type (Ultrium 6250 half height; 3000 half height or Ultrium 3280 full height)
- All drive ports configured to use a “Fabric N/F” connection

The default port configuration for HP StoreEver MSL Tape Libraries is Automatic and must be changed. Figure 12 (page 33) shows the HP StoreEver MSL Tape Library network administration drive configuration pane for a dual-port drive. The configuration for port A is set correctly for use with basic control path failover. The configuration for port B is still set to the default setting of “Automatic”. A single-port drive will not have port B.

Figure 12 Configure library, basic control path failover configuration disabled

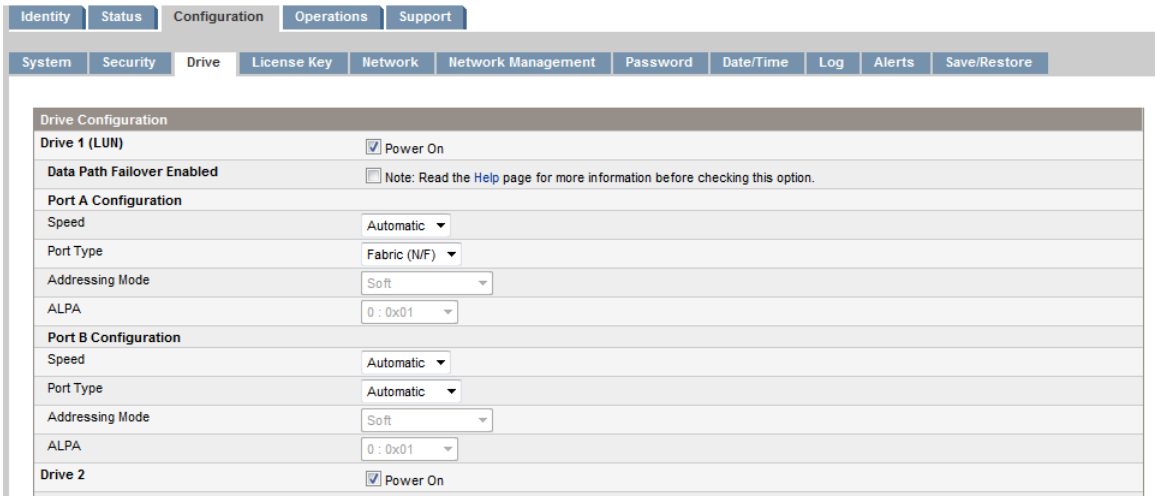
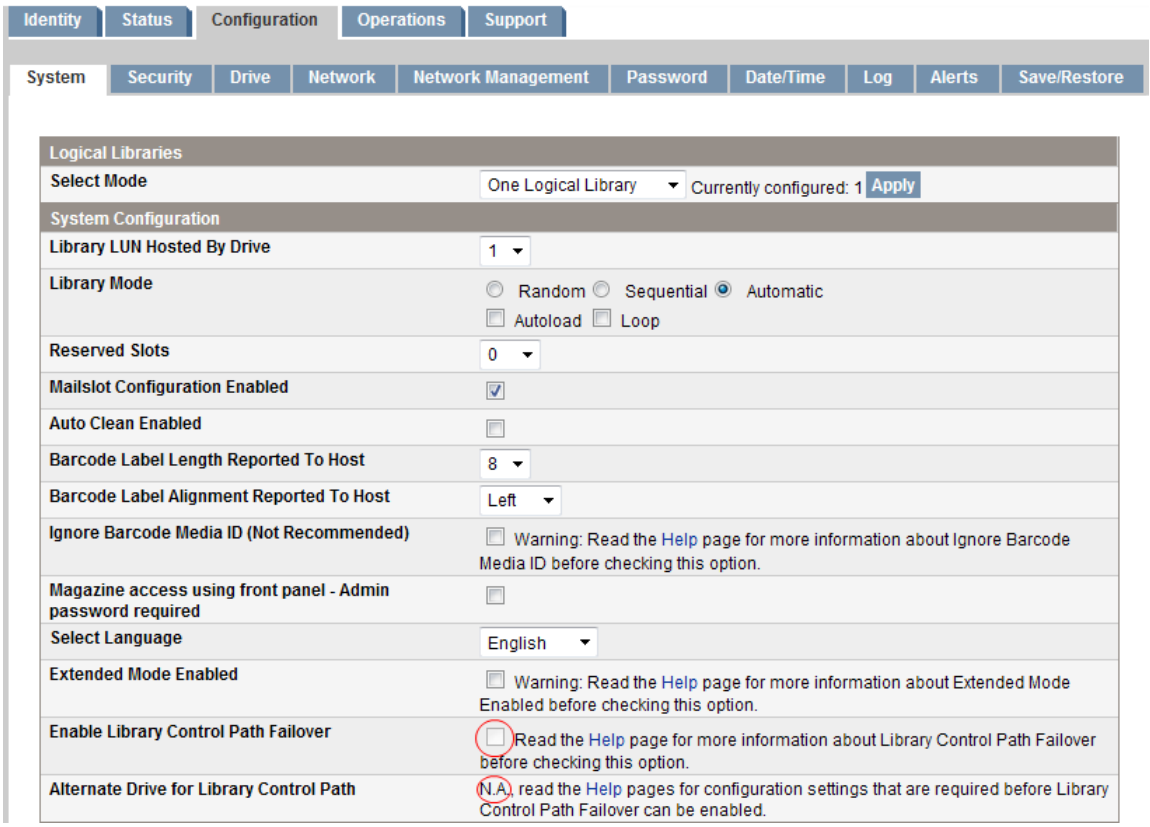


Figure 13 (page 33) and Figure 14 (page 34) show the System configuration pane. In Figure 13 (page 33) the option for **Enable Library Control Path Failover** is not selectable and the option for **Alternate Drive for Library Control Path Failover** is set to **N.A.**. When the options for enabling basic control path failover are not available the configuration requirements have not been met. The configuration shown in Figure 12 (page 33) where only one drive port is configured for Fabric is an example configuration where these options would not be available. Selecting the **Help** link in the note following the option brings up a help page listing the configuration requirements.

Figure 13 Configure library, basic control path failover configuration disabled



In Figure 14 (page 34) the configuration requirements for enabling basic control path failover have been met and the library has made the option for **Enable Library Control Path Failover** selectable as well as providing a selection for the "Alternate Drive for Library Control Path."

Figure 14 Configure library, basic control path failover configuration available

Configuration requirements after enabling control path failure

When basic control path failover is enabled, the library is no longer presented as a logical unit behind the tape drive and is assigned a new Fibre Channel node name.

Verifying basic control path failover

After enabling basic control path failover, verify the configuration of both paths. To verify both paths, first verify that the hosts configured for access to the library are able to communicate with the library. The library Worldwide Node Name might need to be added to switch zones before the library is accessible. After the host access has been verified use the library front panel or the library management interface to power off the drive marked as hosting the library logical unit number **Drive 1 (LUN)** in Figure 12 (page 33) - **Configure: Drives**.

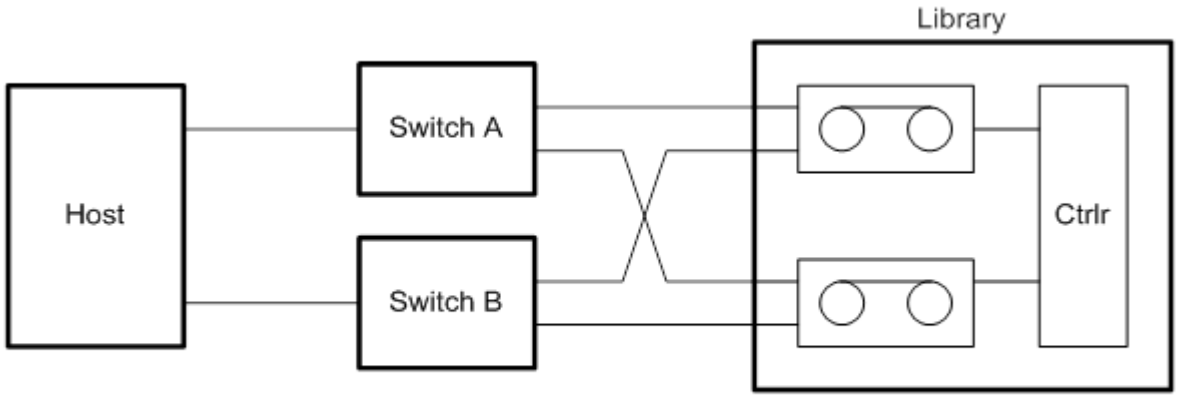
After the library has powered off the drive hosting the library control path, the LUN indicator should move to the alternate control path drive. When the library has reported that the drive has been successfully powered off and the LUN indicator has moved to the alternate control path drive, verify that host connectivity to the library has not changed. It may be necessary to configure switch zoning to allow host access.

After verifying library connectivity using each of the library control paths the library control path may be moved back to the original drive if so desired by using the **Alternate Drive for Library Control Path** option (see Figure 14 (page 34)).

8 Installing and using Windows advanced path failover drivers

After the host has been configured and booted, install both the HP tape and the HP changer drivers. Both the HP tape and the HP changer drivers must be installed before the advanced path failover drivers are installed. The tape and changer drivers are in the HP StoreEver Tape Drivers for Windows driver bundle available from http://www.hp.com/storage/tapecompatibility.

After installation of the tape and changer drivers, use Windows Device Manager to confirm that all of the configured paths are accessible to the OS. If the example system shown below is used, there should be two paths to each tape drive and four paths to the tape library. If the expected number of paths is not available, check the host and SAN configuration. After all of the expected paths are available to the host, the advanced path failover drivers can be installed.



Installing the Windows advanced path failover drivers

"Application path list " (page 36) shows the device handles as presented to a Windows application when using the advanced path failover driver for the same hardware configuration shown in "Advanced path failover" (page 11). For the drives, both ports are mapped to the same device handle and one port is active while the other is the standby port. For the library, the two ports on the first drive are the active and standby ports and two additional ports on a second drive are passive ports that can be activated in the event of complete connection loss to the drive hosting the control path.

Table 2 Application path list

Addressed Logical Unit	Device Handle	Path	SAN	Port	Example Logical Unit Worldwide Identifier
Tape drive 1	TAPE0	Active	1	Port A	50:01:10:a0:00:00:00:01
		Standby	2	Port B	50:01:10:a0:00:00:00:01
Tape drive 2	TAPE1	Active	1	Port A	50:01:10:a0:00:00:00:03
		Standby	2	Port B	50:01:10:a0:00:00:00:03
Library controller	CHANGER0	Active	2	Port B	50:01:10:a0:00:00:00:02
		Standby	1	Port A	50:01:10:a0:00:00:00:02
		Passive	2	Port B	50:01:10:a0:00:00:00:02
		Passive	1	Port A	50:01:10:a0:00:00:00:02

Downloading and installing the drivers

1. Locate the drivers on the HP website:
   a. Navigate to http://www.hp.com/support/storage.
   b. Click **Tape Storage**.
   c. Click **Enterprise Class Tape Libraries** (for ESL G3) or **Tape Libraries** (for MSL6480).
   d. Click **HP StoreEver ESL G3 Tape Libraries** or **HP StoreEver MSL6480 Tape Library**.
   e. In the **Download options** tab, click **Drivers, software & firmware**.
   f. For the ESL G3, select your product.
   g. In the **Operating System** drop down, select **OS Independent**.
   h. Click **Driver — Storage Tape**.
   i. Click **Obtain software** for the High Availability Failover Driver for your operating system.
   j. Click **Receive for Free**.
   k. Follow the prompts to download the driver package.
2. Run the installer file as Administrator to install the Tape Upper Bus Storage Filter driver and restart when requested.

   After the system restarts, the installer will continue installing the Tape Multi-Path Intermediate Class driver.

NOTE: The installation requires Windows Installer version 4.5 or later. If it is not present, the installer reports the following errors:

- Error 0x80070643: Failed to install MSI package
- Error 0x80070643: Failed to execute MSI package.
- Error 0x80070643: Failed to configure per-machine MSI package.
- Error 0x80070643: Failed to configure per-machine MSI package.

If these errors appear, download the Windows Installer appropriate for your version of Windows using the following link:

http://www.microsoft.com/en-us/download/details.aspx?id=8483

The installation process creates a directory:

```
C:\Program Files\Hewlett-Packard\Failover\
```

3. If the server doesn't already have the HP StoreEver Tape Drivers for Windows, you can obtain the driver package from the **Driver — Storage Tape** page as described in Step 1 and then run the installer file as Administrator to install the drivers.

Uninstalling drivers

To remove the drivers:

1. Select **Start→Programs→Control Panel**.
2. Select **Advanced Failover Drivers** entry, click **Uninstall/Change**.
3. Follow the provided prompts to complete the driver removal.

Windows driver theory of operation

The advanced path failover drivers support data path failover and control path failover on HP LTO-6 drives integrated into HP tape libraries.

A failover device driver must identify devices accessible over the different paths available and associate paths with devices so that it is able to mask duplicate paths and present a single path to an ISV application.

As devices are discovered by the operating system and the `DEVICE OBJECT` is passed into the driver for initialization, the driver determines if the device is a tape or changer device and is a candidate for failover. If the device is a candidate for failover, the driver determines the serial number (SN) or worldwide name (WWN) of the device.

If the device is capable of advanced path failover, the driver determines whether failover is enabled for the device. If the device does support failover and failover is enabled, then the driver will mask all duplicate paths and present a single path to application clients. If the device does not support failover, if failover is not enabled, or if an error occurred while attempting to determine the failover-enabled state, then the driver will not modify the presentation of paths to the device to applications.

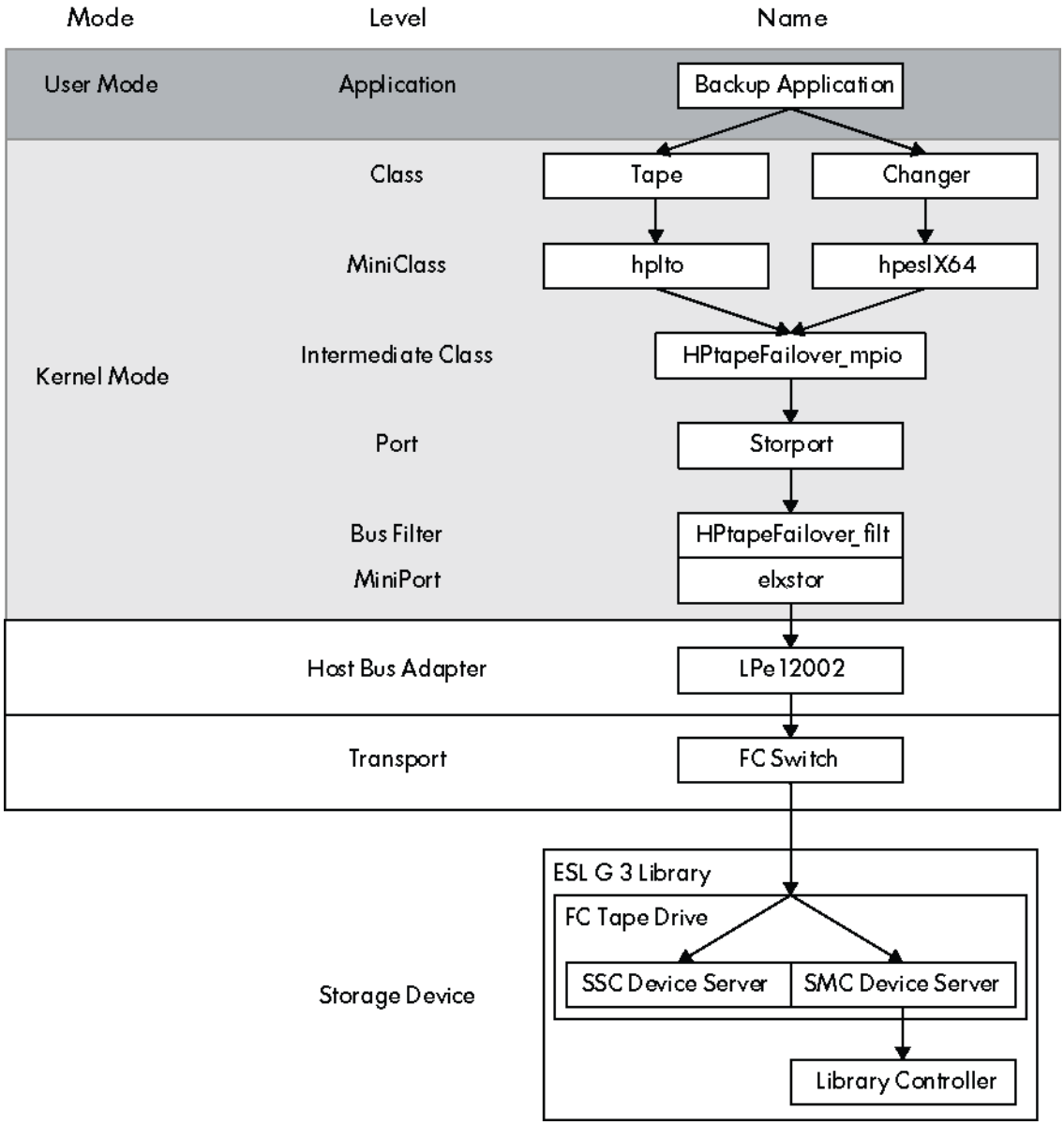
Driver components

Windows advanced path failover drivers consists of two drivers: a storage bus filter driver and an intermediate class driver. The storage bus filter driver processes OS device notifications (PnP notifications) to identify available paths to tape and media changer devices capable of supporting advanced path failover. The intermediate class driver works with the devices that have been identified as advanced path failover capable devices and manages the active paths to the changer and tape drives.

This architecture follows the architecture of Microsoft's MPIO. MPIO only supports disk devices and cannot be used directly.

Figure 15 (page 38) shows the organization of the Windows drivers and the system components when an Emulex LPe12002 host bus adapter is installed. In this example, the tape drive presents both SSC (tape) and SMC (media changer) device servers. Not all drives in the library will present an SMC device server.

Figure 15 Driver and system organization



Storage bus filter driver

The storage bus filter driver is named `HPtapeFailover_filt` and manages the OS notifications indicating that devices have been added or removed. The storage bus filter driver bus enumerator is usually "PCI". It attaches as an upper filter to all HBA drivers. It then monitors the creation of raw devices, looking for supported failover capable devices. Requests to all other devices are passed through unchanged. When a supported device is recognized, the hardware ID of the device is changed to a value that the upper device driver will recognize, but that the rest of the system will not. The special hardware ID prevents the standard tape class driver from attaching to the raw paths.

Multi-path intermediate class driver

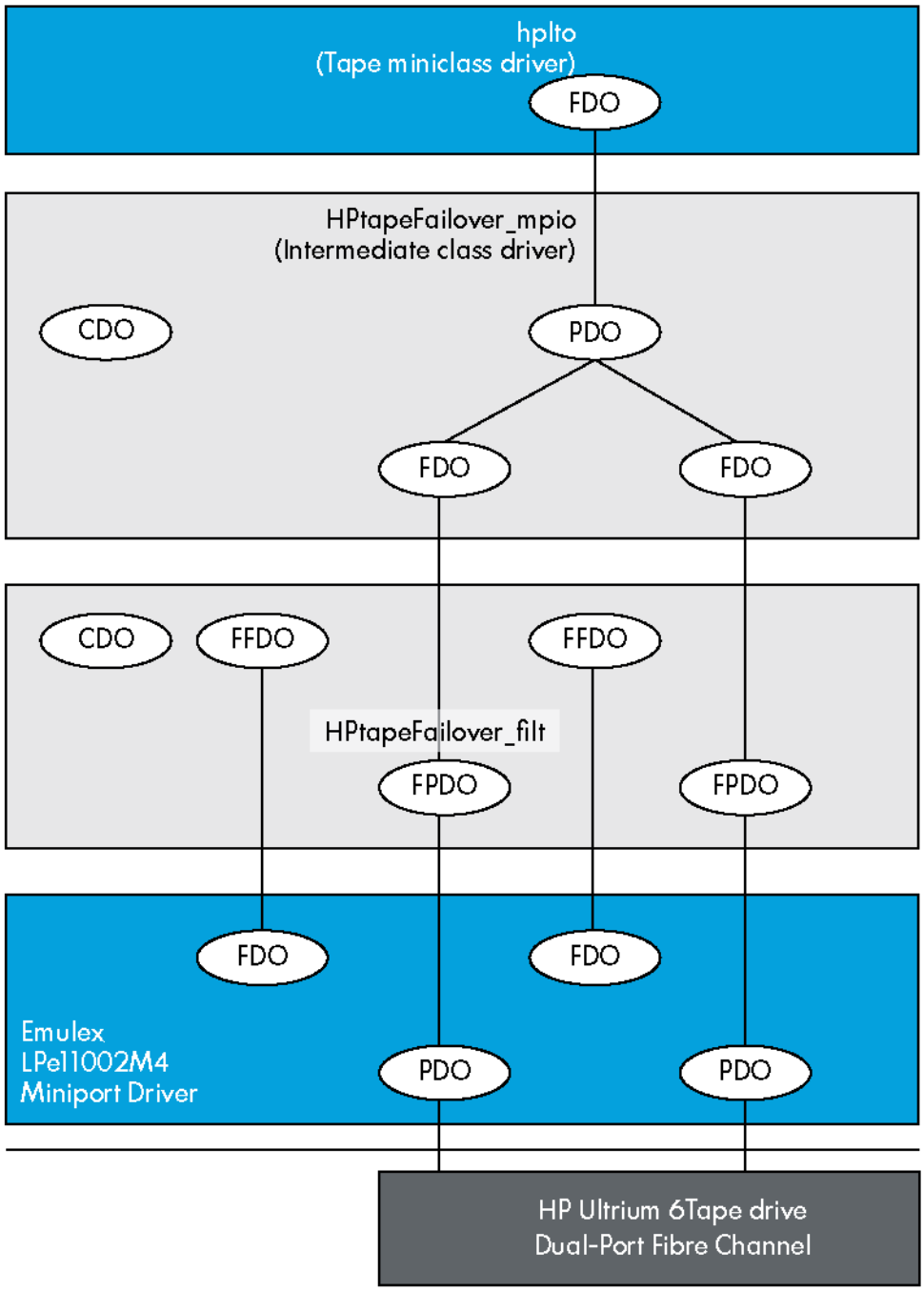
The intermediate class (IC) driver, `HPtapeFailover_mpio`, has two halves. The upper half is a virtual bus (VB) driver. This VB driver provides a virtual device which manages the paths to all of the devices that support failover. The lower half is a multi-path function driver for the devices using the hardware ID created by the lower level filter driver. Windows calls these hardware paths physical device objects (PDOs). The intermediate class driver creates two different type of devices in the Windows device manager. The devices associated with the physical paths is shown as a "SCSI" bus and the device associated with the virtual device that manages the paths is shown as a "ROOT" device.

The lower half of this driver acts like a class driver and it attaches to the devices presented by the lower driver. The upper half acts like a virtual bus driver, presenting abstractions of devices to the layers above. For example, a single tape device may have many paths to it, but only a single virtual tape device is presented to the layers above, and the driver transparently manages the multiple paths to the physical tape device.

Figure 16 (page 40) shows the various device objects presented by the drivers. The abbreviations are:

- PDO: Physical device object
- FDO: Functional device object
- FPDO: PDO created by bus filter driver
- FFDO: FDO created by bus filter driver
- CDO: Control device object; used by diagnostic interface

Figure 16 Drivers and device objects

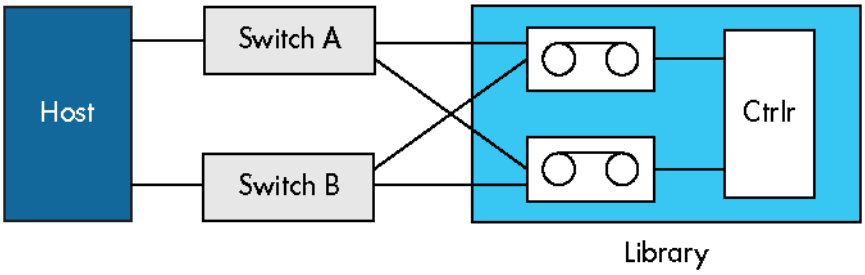


Device manager view

The Windows Device Manager shows the instances of the failover paths which are configured Figure 18 (page 42).

In the system shown in Figure 17 the library has two tape drives and each tape drive has two primary ports attached to a different switch. Each drive port presents both tape drive (SSC) and tape library (SMC) devices. One of the drives will be configured to present the active tape library device paths and the second drive will be configured to present passive tape library device paths. All tape drive paths are active.

Figure 17 Library configuration example



In this example, there are two physical tape drives in the library; each of these is shown under "Tape drives" as "Hewlett Packard LTO Ultrium-6 drive." At boot time, the drivers discovered eight paths to supported SCSI devices in the system, although not all paths were in active use.

Each drive has an SSC device (i.e., tape drive) and an SMC device (i.e., media changer). Each of those can potentially be accessed through either of the drive's two primary ports, for a total of two paths per drive and eight paths total (4 tape drive paths, two each on 2 drives, and 4 media changer paths to one media changer).

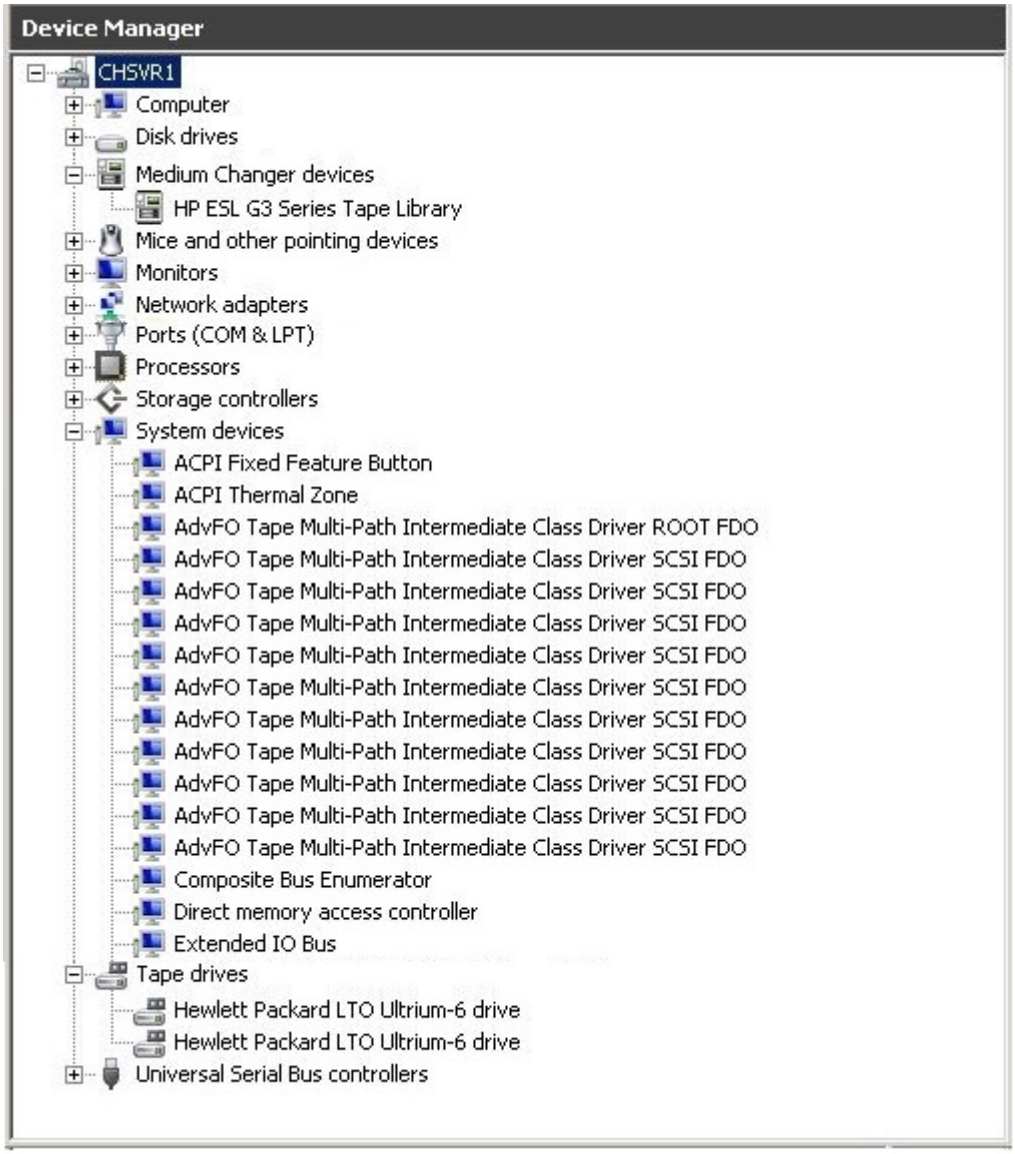
The failover drivers have one path to each of the two tape drives through Switch A. The failover drivers also have one path to each of the two tape drives through Switch B. Each of those four paths can potentially connect to either the tape drive or the tape library. At boot time the drivers discover a total of eight potential paths to devices.

This results in the Windows Device Manager view that is shown in Figure 18 (page 42). The failover paths appear under **System devices**. A virtual bus named **AdvFO Tape Multi-Path Intermediate Class Driver ROOT FDO** is created to enumerate the multi-path capable devices. Each of the eight paths appears as **AdvFO Tape Multi-Path Intermediate Class Driver SCSI FDO**.

The drivers make one path active to each tape drive and one path to the tape library active through the drive hosting the active control paths. Each physical device appears once in the **Device Manager**. Under **Tape drives** there are two instances of **Hewlett Packard LTO Ultrium 6 drive** and under **Medium Changer devices** there is one instance of **HP ESL G3 Tape Library**.

NOTE: A number of devices have been removed from this view to improve readability.

Figure 18 Device manager window



Device firmware

These two Windows drivers work in conjunction with firmware in the library and tape devices. The special firmware ensures that the host computer and devices stay synchronized on state and position information. The advanced path failover device drivers hide the details of this from the rest of the system.

The objective is for the rest of the system (including all applications running on the system and all other device drivers) to see a single changer or tape device, but not the redundant paths to the failover-enabled devices. If a path failure occurs, it should be transparent to the rest of the system including applications. If a path fails, the drivers work with the device to transfer communication to a new path and recover the command that was in process when the path failed.

9 Installing and using Linux advanced path failover drivers

The advanced path failover drivers for Linux replace the normal SCSI Tape and SCSI Generic drivers. The advanced path failover drivers for Linux pass all SCSI commands for devices that do not support advanced path failover through the same code path that is followed when the standard drivers are loaded and route commands for devices that do support failover through the new `pfo` driver. The advanced path failover drivers for Linux perform automatic load balancing and will automatically select a path with the fewest open tape devices.

Installing advanced path failover drivers

1. For systems using Symantec NetBackup: Using the advanced path failover drivers with NetBackup requires the creation of specific paths in the `sys` filesystem. To allow the advanced path failover drivers to create the necessary directories when the drivers are installed:

   ```
   echo "options pfo netbackup=1" > /etc/modprobe.d/pfo-netbackup.conf
   ```

2. Download the drivers for the revision of Linux running on the server. Drivers for a specific revision of Linux will not operate properly in other revisions. See the most recent release notes to find out which RPM file to use for the Linux operating system that is running on the server.
   a. Navigate to http://www.hp.com/support/storage.
   b. Click **Tape Storage**.
   c. Click **Enterprise Class Tape Libraries** (for ESL G3) or **Tape Libraries** (for MSL6480).
   d. Click **HP StoreEver ESL G3 Tape Libraries** or **HP StoreEver MSL6480 Tape Library**.
   e. In the **Download options** tab, click **Drivers, software & firmware**.
   f. For the ESL G3, select your product.
   g. In the **Operating System** drop down, select **OS Independent**.
   h. Click **Driver — Storage Tape**.
   i. Click **Obtain software** for the High Availability Failover Driver for your operating system.
   j. Click **Receive for Free**.
   k. Follow the prompts to download the driver package.
3. To install the drivers:

   ```
   rpm -ivh<filename>.rpm
   ```

   The `filename` is version dependent. See the release notes for filenames for the version you are installing.
4. In some cases the server will need to be rebooted to complete the installation. Check the instructions provided by the RPM file output and reboot the server if requested.

Updating the driver without rebooting

The advanced path failover driver may be updated without rebooting the system by first removing the existing drivers and then loading the new version. Verify that no applications have devices open that are using the advanced path failover drivers and then use `rpm -U <filename>.rpm` to update the drivers. See the release notes for specific file names.

Device files

The advanced path failover driver will resolve all paths to a device into a single 'sg' and 'st' entry in the `/dev` directory for each device. Requests to open or send commands to that device path will use the path selected by the advanced path failover driver. Alternate paths that address devices that are already known are entered into an internal alternate path list and device files are not created for those paths.

Command line user interface

The advanced path failover drivers support several configuration and diagnostic functions through a command line interface. Most of the functions are accessed by directing commands to a specific path. The following example shows the command for a specific path and the commands may be directed at any path by replacing the device identifier with the identifier from the sg or st device. For example, a command executed on `pfo3` will report information for the device at `sg3` and `st3`.

Viewing the current driver revision

The driver revision number indicates the build date of the driver and can be viewed by running:

```
cat /proc/scsi/sg/version
```

Viewing device status

You can view the status of a device that is controlled by the failover driver by reading a file in the /sys file system. For example, to see the path status for /dev/sg3:

```
cat /sys/class/pfo/pfo3/paths
```

Terms

active_drive	A path to a tape library via an advanced path failover active drive.
down	The driver is aware of this path, but if the driver attempted to use this path at this time it would fail and another path would need to be chosen.
last	The path that the driver was most recently able to successfully perform a SCSI command on. This is probably the path that will be used next. There are no `/dev` files open to this device.
open	The path that the driver was most recently able to successfully perform a SCSI command on. This is probably the path that will be used next. There is at least one `/dev` file open to this device.
prefer	The driver will attempt to send the commands on this path after the next device file open() call. This path will override the last known good path.
session_key	The identifier number of the open session, in hexadecimal.
wwnn	World-wide node name of the device.
wwpn	World-wide port name of the Fibre Channel port on the device.

Example 1 Example paths

```
# cat /sys/class/pfo/*/paths
sg=/dev/sg0  st=/dev/st0  wwnn=50014382c6c2f001 type=tape
0:0:3:0  up   -    -      wwpn=50014382c6c2f003
0:0:0:0  up   -    -      wwpn=50014382c6c2f002
1:0:0:0  up   -    -      wwpn=50014382c6c2f002
1:0:2:0  up   -    -      wwpn=50014382c6c2f003
sg=/dev/sg1  st=none wwnn=50014382c6c2f800 type=changer session_key=cae82d14
0:0:3:1  up   -    -      active_drive
0:0:0:1  up   last prefer active_drive
0:0:1:1  up   -    -      -
0:0:2:1  up   -    -      -
1:0:0:1  up   -    -      active_drive
1:0:1:1  up   -    -      -
1:0:2:1  up   -    -      active_drive
1:0:3:1  up   -    -      -
sg=/dev/sg2  st=/dev/st1  wwnn=50014382c6c2f007 type=tape
0:0:1:0  up   -    -      wwpn=50014382c6c2f008
0:0:2:0  up   open -      wwpn=50014382c6c2f009
1:0:1:0  up   -    -      wwpn=50014382c6c2f008
1:0:3:0  up   -    -      wwpn=50014382c6c2f009
```

In this example, the tape drive at the top of the list can be accessed via either /dev/sg0 or /dev/st0. The other tape drive is available via either /dev/sg2 or /dev/st1. An application has a device file open to the drive at the bottom of the list; and the most recent command was sent to the drive via the path 0:0:2:0.

The library is accessed via `/dev/sg1`. The path most recently used to access the library was `0:0:0:1`. At some time in the past an administrator specified path 0:0:0:1 to be the “preferred” path to the library.

There are four paths to each drive. Since both drives are connected to the library there appear to be eight paths available to the library. The drive at `/dev/st0` is the “active_drive,” which means that the driver will use that drive to access the library. The active drive can be inferred by looking at the path numbers. The last digit (e.g. the 1 in 0:0:0:1) is the lun number of the device accessed by that path. A drive has a LUN of 0. A library has a LUN of 1. The port names are not reported by the library because the library uses ports on the drives so the port names are not available in the report.

All of the paths show their status as being “up”. This means that the driver believes that all of those paths are currently available for use. The state of “down” is temporary. It is only visible while the path is being destroyed. Once the path becomes completely unusable, the driver removes it from the list. Any path that remains in a “down” state for more than a second should be disconnected and reconnected to reestablish a reliable connection. The path cannot be disconnected via the Linux operating system; disconnect the path by physically disconnecting the FC cable, disabling the port in the FC switch, or power cycling the drive.

Setting the preferred path

Normally the driver attempts to use the path with the fewest number of open tape drive device files. You can override the path by selecting a "preferred" path. The preferred path is the path that the driver will attempt to use at the next `open()` of the device file.

The path will not switch to the preferred path if there is any other thread holding the `/dev` file open. If multiple threads have the `/dev` file open, the driver will not interfere with the path selection that has been made by another thread.

The path will not change to the preferred path if it is indicating a library control path using a passive drive. In this case, the driver will select a control path hosted by an active drive instead.

You can configure the preferred path by writing to a `/sys` file. For example, to configure a preferred path on /dev/sg5:

```
echo prefer=8:0:1:0 > /sys/class/pfo/pfo5/ctrl
```

You can disable the configuration of a preferred path by creating an empty prefer entry in the `crtl` file. For example:

```
echo prefer > /sys/class/pfo/pfo5/ctrl
```

Path rotation exercise function

Path rotation is a test function that will cause the driver to change the path it uses each time the device file is closed and reopened.

To cause the path to change with every `open()` of the `/dev` file, set `rotate=1`. For example:

```
echo rotate=1 > /sys/bus/scsi/drivers/pfo/ctrl
```

To stop path rotation, set `rotate=0`. For example:

```
echo rotate=0 > /sys/bus/scsi/drivers/pfo/ctrl
```

Enabling advanced path failover on a device while the driver is running

If a device has any advanced path failover feature disabled when advanced path failover is enabled, the device will reset itself, removing the old `/dev` file. When the device comes back up, it will be recognized as an advanced path failover device. It will then operate normally as an advanced path failover device. It may not have the same `/dev` file name as before the switch.

Disabling advanced path failover on a device while the driver is running

Disabling advanced path failover while a device is running is not recommended because the paths will not be cleanly removed and reassociated. If advanced path failover is disabled on any device, the Linux server will need to be rebooted. When possible, power down the Linux server cleanly, and then disable advanced path failover on the device, and then boot the Linux server.

Linux driver theory of operation

The Linux advanced path failover drivers support data path failover and control path failover on HP LTO-6 FC drives integrated into HP libraries. The failover functionality is provided by the `pfo` driver and modifications are made to the standard `st` and `sg` drivers to call into the `pfo` driver if a device supports advanced path failover. The modified `st` and `sg` drivers are called `stmp` and `sgmp`.

The failover device driver must identify devices accessible over the different paths available and associate paths with devices so that the driver can mask duplicate paths and present a single path to an application.

As devices are discovered by the operating system and the device information is passed into the driver for initialization, the driver determines if the device is a tape or library device, and if so, whether it is a candidate for failover. If the device is a candidate for failover, the driver determines the serial number (SN) or worldwide name (WWN) of the device. If the device is capable of advanced path failover, the driver determines whether failover is enabled for the device. If the device supports advanced failover and failover is enabled, the driver masks all duplicate paths and presents a single path to application clients. If the device does not support advanced failover or if failover is not enabled, the driver will not modify the presentation of device paths to applications.

To improve throughput for multiple tape drives, the driver attempts to balance the number of tape drives on each HBA path. When opening a tape drive device file, the driver selects the path with the fewest number of open tape drive device files. The load balancing algorithm does not take path speed into account when selecting a path. If the load balancing algorithm cannot select an appropriate path, it will select the last known good path or another available path. If a “preferred” path is configured, this path will take precedence over the load balancing method. (See “Setting the preferred path” (page 45).)

Load balancing is only applied when a tape drive device file is opened by the first thread; the paths are not reevaluated at other times. For example:

- The failover algorithms do not consider other tape drive paths when selecting a path.
- The path is not changed if another thread already has the tape drive device file open.
- The path is not changed during data transfers.

10 Installing and using HP-UX advanced path failover drivers

Advanced path failover for HP-UX is implemented by updating HP-UX drivers to support advanced path failover with the LTO-6 tape drives. The drivers function as both failover and non-failover drivers.

The updated drivers are:

- HP-UX tape driver (estape) — used for data path failover
- HP-UX media changer driver (eschgr) — used for control path failover
- HP-UX SCSI stack driver (esctl) — used for data path and control path failover

During the device open, the device driver checks to see whether the device is capable and enabled for advanced path failover. If so, the device driver opens a failover session and continues with further device operations. Otherwise, the driver uses the non-failover driver code. Note that until the device is opened for the first time, the drivers do not know whether the device is capable of advanced path failover or not.

HP-UX 11i v3 performs automatic load balancing and will open new tape drive connections using the best available path to spread the load across all available paths. In HP-UX 11i v3, the default load balance policy for tape drives and libraries is the "Path-lockdown" policy. With this policy, the host determines a path for sending I/O requests to the device when the device is opened for the first time and this path remains fixed. Without the advanced path failover feature installed, if this path fails, a new path is only chosen when the device is next opened. With the advanced path failover feature, the best path will be chosen as the lockdown path. If this path fails, the driver will automatically fail over to the next available best path, which becomes the new lockdown path for all further I/O requests.

For additional information see the following man pages: scsimgr(1M), ioscan(1M), mknod(2), mksf(1M), rmsf(1M).

Installing advanced path failover drivers

HP-UX patches are available at https://h20566.www2.hp.com/portal/site/hpsc/patch/home/. To locate the patches, search for `estape`, `eschgr`, and `esctl`, or the patch number and then look at the **Prepby** field to see if there is a superseding patch.

To install the advanced path failover drivers, use the standard HP-UX kernel patch installation process to install the following patches on the HP-UX host servers running HP-UX 11i v3:

- HP-UX Tape driver patch (estape) - PHKL_43680 or superseding patch
- HP-UX Media changer driver patch (eschgr) - PHKL_43681 or superseding patch
- HP-UX SCSI stack (Mass storage stack) driver patch (esctl) – PHKL_43819 or superseding patch

The server will automatically reboot as part of the installation process.

Commands for viewing tape and library devices connected to a system

You can use ioscan to view the tape and library (media changer) devices connected to the HP-UX host. The device special file (DSF) is listed as the last item in the description as shown in **bold type**.

Example 2 Using ioscan (1M) to view tape devices

```
# ioscan -knNfC tape
Class     I  H/W Path           Driver   S/W State   H/W Type     Description
============================================================================
tape      18  64000/0xfa00/0xd   estape   CLAIMED     DEVICE       HP Ultrium 6-SCSI
          /dev/rtape/tape18_BEST   /dev/rtape/tape18_BESTb   /dev/rtape/tape18_BESTn /dev/rtape/tape18_BESTnb

tape      20  64000/0xfa00/0xf   estape   CLAIMED     DEVICE       HP Ultrium 6-SCSI
          /dev/rtape/tape20_BEST   /dev/rtape/tape20_BESTb   /dev/rtape/tape20_BESTn /dev/rtape/tape20_BESTnb
```

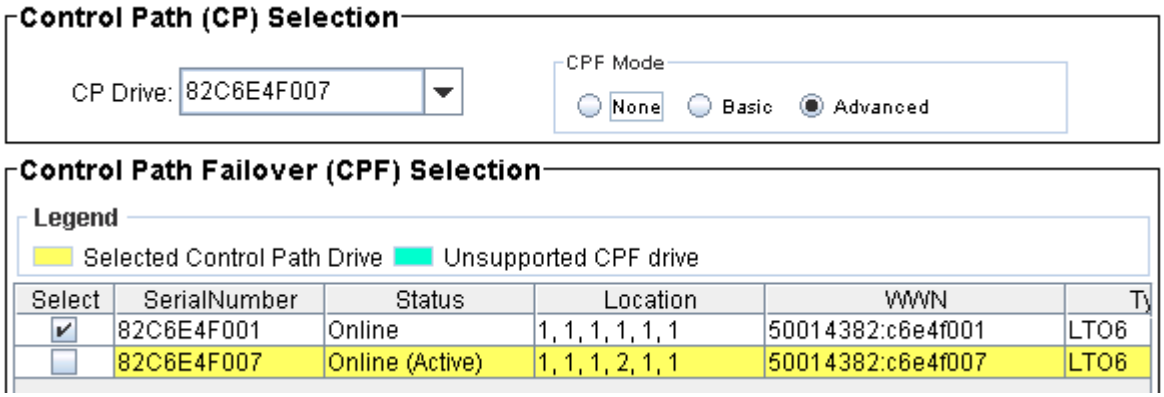
Example 3 Using ioscan (1M) to view library devices

```
# ioscan -knNfC autoch
Class     I  H/W Path           Driver   S/W State   H/W Type     Description
============================================================================
autoch    18  64000/0xfa00/0x12  eschgr   CLAIMED     DEVICE       HP ESL G3 Series /dev/rchgr/autoch18
autoch    19  64000/0xfa00/0x13  eschgr   CLAIMED     DEVICE       HP ESL G3 Series /dev/rchgr/autoch19
autoch    20  64000/0xfa00/0x14  eschgr   CLAIMED     DEVICE       HP ESL G3 Series /dev/rchgr/autoch20
autoch    30  64000/0xfa00/0x3e  eschgr   CLAIMED     DEVICE       HP MSL6000 Series /dev/rchgr/autoch30
```

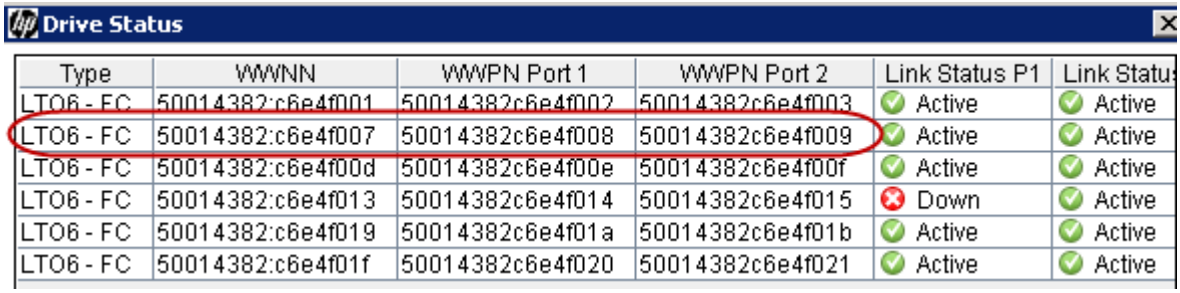
Example 4 Finding HP-UX paths for drives listed on the library interface

This example shows how the drive and port information displayed in the ESL G3 library web interface can be seen from the HP-UX host.

On the **Control Path (CP) Selection** screen for a partition, the drive with serial number 82C6E4F007 is the drive with the control path for the partition.



Using the control path drive's WWN in the Drive Status screen, you can find the corresponding target ports, which in this example are 50014382c6e4f008 and 50014382c6e4f009.



To find this information with HP-UX commands, use `ioscan -knNfC autoch` to see the list of tape libraries, and then use `ioscan -m lun -H <H/W path>` for the partition. For example, if the LUN hardware path for the library is **`64000/0xfa00/0x12`**:

```
# ioscan -m lun -H 64000/0xfa00/0x12
Class     I  Lun H/W Path        Driver  S/W State   H/W Type     Health   Description
==========================================================================================
autoch   18  64000/0xfa00/0x12   eschgr  CLAIMED     DEVICE       limited  HP ESL G3 Series
        0/0/0/9/0/0/1.0x50014382c6e4f002.0x1000000000000 <- Passive control path
        0/0/0/9/0/0/1.0x50014382c6e4f003.0x1000000000000 <- Passive control path
        0/0/0/9/0/0/1.0x50014382c6e4f009.0x1000000000000 <- Active control path
        0/0/0/9/0/0/1.0x50014382c6e4f008.0x1000000000000 <- Active control path
        0/0/0/9/0/0/0.0x50014382c6e4f003.0x1000000000000 <- Passive control path
        0/0/0/9/0/0/0.0x50014382c6e4f009.0x1000000000000 <- Active control path
        0/0/0/9/0/0/0.0x50014382c6e4f008.0x1000000000000 <- Active control path
        0/0/0/9/0/0/0.0x50014382c6e4f002.0x1000000000000 <- Passive control path
             /dev/rchgr/autoch18 <- Device special file for media changer
```

The reported LUN hardware path has three parts, separated by a period. For example, in the path

```
0/0/0/9/0/0/0.0x50014382c6e4f002.0x1000000000000
   Part 1     .      Part 2        .    Part 3
```

- Part 1: Hardware path for the HBA. In this example, `0/0/0/9/0/0/0`.
- Part 2: Target port WWN. In this example, `0x50014382c6e4f002`. This is the WWN that is displayed in the library web interface.
- Part 3: LUN identifier: In this example, `0x1000000000000`.

Similarly, to find the special files for tape drives, use `ioscan -knNfC tape` to list the tape drives and then use `ioscan -m lun -H <H/W path>` to see information for the drive. For example, if the LUN hardware path to the tape drive is **`64000/0xfa00/0x37`**:

```
# ioscan -m lun -H 64000/0xfa00/0x37
Class     I  Lun H/W Path       Driver  S/W State   H/W Type     Health  Description
==========================================================================================
tape      29  64000/0xfa00/0x37   estape  CLAIMED     DEVICE       online  HP      Ultrium 6-SCSI
          0/0/0/9/0/0/1.0x50014382c6e4f009.0x0 <- Tape device special file
          0/0/0/9/0/0/1.0x50014382c6e4f008.0x0 <- Tape device special file
          0/0/0/9/0/0/0.0x50014382c6e4f009.0x0 <- Tape device special file
          0/0/0/9/0/0/0.0x50014382c6e4f008.0x0 <- Tape device special file
               /dev/rtape/tape29_BEST    /dev/rtape/tape29_BESTb   /dev/rtape/tape29_BESTn
/dev/rtape/tape29_BESTnb <- Tape device special files
```

Finding the lockdown path

The load-balance policy used to route data on multiple paths to a tape drive or library is called the "path-lockdown" policy. Use the `scsimgr get_info` command to see the current lockdown path for a library. For example:

```
# scsimgr get_info -D /dev/rchgr/autoch35
    STATUS INFORMATION FOR LUN : /dev/rchgr/autoch38
...
LUN Path used when policy is path_lockdown = 0/0/0/9/0/0/1.0x50014382c6e4f009.0x1000000000000
```

Use the `scsimgr get_attr` command to see the current lockdown path for a library. For example:

```
# scsimgr get_attr -D /dev/rtape/tape28_BEST
    SCSI ATTRIBUTES FOR LUN : /dev/rtape/tape28_BEST
...
    name = lpt_lockdown
    current = 0/0/0/9/0/0/0.0x100000e00222a6c1.0x2000000000000
    default =
    saved =
```

For additional information, see the HP-UX man pages: `scsimgr (1M)`, `ioscan (1M)`, `mknod (2)`, `mksf (1M)`, `rmsf (1M)`.

Troubleshooting advanced path failover

Advanced path failover errors are logged in the `/var/adm/syslog/syslog.log` file as part of the default SCSI I/O tracing function of HP-UX. You can use standard file viewing commands, including `cat`, `vi`, `dmesg -`, and `tail -f`, to view the `syslog.log` file.

Enabling or disabling advanced path failover

Advanced path failover is disabled by default. When advanced path failover is disabled, the driver operates as if the device is not capable of using the advanced path failover feature.

When advanced failover is enabled for the library or tape drive, the device resets itself and must be opened using the device special file before the driver will recognise it as an advanced path failover device and use the failover features of the driver. Opening the device is generally done by the host applications.

You can enable or disable advanced path failover using the library web-based interface. For instructions, see:

- "Enabling control path failover for the ESL G3" (page 24)
- "Enabling data path failover for the MSL6480" (page 29)

When advanced path failover is disabled, the passive control paths to the library will go into an error state (NO_HW). in the ioscan (1M) command output. These stale entries do not affect the function of the library. To clear this errors so the device can be accessed using its device special file:

1. On the HP-UX host, run `rmsf -H` on the lunpath hardware paths that are in NO_HW state. For example:

   ```
   rmsf –H 0/4/0/0/0/1.0x50014380023560d4.0x1000000000000
   ```

2. Run `ioscan -kfNH <HBA path>`. For example:

   ```
   ioscan -kfNH 0/4/0/0/0
   ```

HP recommends only enabling or disabling advanced path failover when the library is not opened by any applications. If the advanced path failover is disabled while an application is accessing the library, all of the library's lunpaths will go offline and I/O requests to the library will fail.

11 Troubleshooting failover operation

To find diagnostic information about the operation of basic and advanced path failover:

- Examine the library event log or RAS tickets. See "Library path failover events" (page 62) and "Additional tape drive sense codes" (page 65).
- Examine the Windows Device Manager view of tape drives and media changers. See "Confirming path failover on Windows" (page 54).
- Tape drive support tickets contain more detailed information that may be required by HP support.

To find additional diagnostic information for advanced path failover:

- Examine the host log files for entries from the advanced path failover drivers.
  - "Windows system log" (page 55)
  - Linux or HP-UX `/var/adm/syslog/syslog.log`
- Use host-specific utilities to view the status of the drivers.
  - "Windows Advanced Failover Diagnostic Application" (page 56)
  - "Linux command line user interface" (page 44)
  - "HP-UX commands for viewing tape and library devices" (page 48)
- Optionally install Windows debug (checked build) drivers, which will save a crash dump in the event of a system crash. See "Windows driver debug dump setup" (page 66).
- Use the Windows Advanced Failover Diagnostic application to clear library reservations and prevent media removal settings if "Reservation Conflict" or "Medium Removal Prevented" errors occur.

NOTE: For known issues and workarounds, see "Known issues and workarounds" (page 69).

Locating a failed path

The system administrator should have a map of the storage area network, which will indicate how ports on the various devices (hosts, switches, and libraries) are connected to one another.

Common causes of failed paths are:

- Loose or unplugged cables
- Loose or unplugged Fibre Channel transceivers
- Failed switch ports
- Powered-off switches
- Failed host bus adapter ports

The first sign of a path failure, such as a disconnected Fibre Channel cable or a failed switch, is often an alert or warning reported by the library in the web interface and event log. Failure of a single path to a drive should not interfere with operation of most backup applications, and might go unnoticed. To ensure that path failover functionality is restored for the next path failure, correct the problem as soon as possible.

To locate and correct path failures:

1. Examine the library event or RAS ticket indicating that failover has occurred. The Serial # is that of the tape drive with the failed path and the tape drive coordinates indicate the physical location of the drive. (See information about Tape Drive Location Coordinates in the library user guide.)
2. Use host utilities to confirm the failure.
   - On Windows, use the diagnostic application.
     1. Launch the application, or if it is already running go to **Actions→Refresh Cached Driver Data (F5)**.
     2. In the **Devices** pane, locate the drive whose serial number matches that from the support ticket. Select the device.
     3. In the **Paths** pane, confirm that not all of the ports are available.
   - "Linux command line user interface" (page 44)
   - "HP-UX commands for viewing tape and library devices" (page 48)
3. Locate the failed connection or SAN component.
   a. Using the location coordinates of the drive, locate the drive and examine the two Status LEDs labeled "Port 1" and "Port 2." If either of those LEDs is off, the port with the unlit LED is the failed link.
   b. If the status LEDs are both lit and the library is connected to an external switch, use the Fibre Channel switch management feature to locate ports that are not functioning.
   c. Examine the Fibre Channel host bus adapters in the host. If one has a light that indicates a malfunction, that might be the problematic link.

After correcting the connection problem, refresh the diagnostic application to confirm that all of the expected failover paths are available on all devices.

Windows debugging logs and tools

Confirming failover operation

To confirm that the advanced path failover drivers have installed and are operating correctly, open the system event viewer. See "Driver components" (page 37) for instructions on how to filter out irrelevant events. The following events should be present; the first event in this list will be the first to occur after system restart:

HPtapeFailover_filt	Path failover driver loaded
HPtapeFailover_mpio	Path failover driver loaded

Followed by one instance of the following message for each active path:

HPtapeFailover_mpio	Path failover session established…

For more details on which paths are active and passive, use the diagnostic application (see "Windows Advanced Failover Diagnostic Application" (page 56)).

Windows system log

The drivers create entries in the Windows system log when they are first started and whenever any exceptional conditions occur. These log entries are summarized in Table 3 (page 55). The symbols beginning with '%' are strings filled in by the operating system when the log entry is generated.

Table 3 Event Log Entries

Event	Severity	Message
Driver loaded	Informational	Path failover driver loaded
Driver unable to load	Error	Path failover driver unable to load
Path failure detected	Error	Path failure detected on SCSI Port %s Bus %3 Target Id %4 Logical Unit %5
Path removal reported by Windows	Error	Path removal reported on SCSI Port %1 SCSI Bus %2 Target ID %3 Logical Unit %4
Device serial number for failing path	Informational	Device ID: %1
Device Names for failing path	Informational	Device WWNN: %1-%2 Device WWPN: %3-%4 Host WWPN: %5-%6
Error reported for failing path	Informational	Device error: NT status = %1. SCSI Status = %2, Sense Key = %3, ASC/ASCQ = %4/%5, Drive Error Code = %6/%7
Failover session established	Informational	Failover session established on SCSI Port %2 SCSI Bus %3 Target Id %4 Logical Unit %5
Failover session establishment error	Error	Failover session establishment error on SCSI Port %2 SCSI Bus %3 Target Id %4 Logical Unit %5. Reason code %6.[1]
No alternate paths available	Error	No alternate paths for device ID: %1
Alternate path selected after a path failure	Informational	Alternate Path selected: SCSI Port %1 SCSI Bus %2 Target Id %3 Logical Unit %4.
Failure to transition a passive control path drive to active	Error	License key error: NT status = %1. SCSI Status = %2, Sense Key = %3, ASC/ASCQ = %4/%5, Drive Error Code = %6/%7.
Failure to notify device of a failover operation (NCN failure)	Error	Nexus change notification failure: NT status = %1. SCSI Status = %2, Sense Key = %3, ASC/ASCQ = %4/%5, Drive Error Code = %6/%7.
Hardware error from device on NCN	Informational	Nexus change notification will retry after: Sense Key = %1, ASC/ASCQ = %2/%3.
Unrecoverable error in failover sequence negotiation after NCN failure.	Informational	Recovery aborted, sense data modified: Sense Key = %1, ASC/ASCQ = %2/%3.
Sense information from a device requires a new failover session be established	Informational	A new session will be created after: NT status = %1. SCSI Status = %2, Sense Key = %3, ASC/ASCQ = %4/%5, Drive Error Code = %6/%7.
Unable to retrieve logged in host table from a tape drive	Informational	Retrieve logged in host name failed: NT status = %1. SCSI Status = %2, Sense Key = %3, ASC/ASCQ = %4/%5, Drive Error Code = %6/%7.

[1] The *reason code* for a failover session establishment error is a Windows system error number. Include the reason code with the rest of the message in any report sent to technical support.

For simplified viewing, the Windows system Event Log may be filtered using the 'Actions' panel and selecting just events from `HPtapeFailover_filt` and `HPtapeFailover_mpio`. Including events from `UserPnp` may also provide additional helpful information.

Diagnostic application

The Advanced Failover Diagnostic application communicates with the drivers to obtain the state of failover sessions. The diagnostic application is installed with the driver and can be found in the driver installation directory:

`C:\Program Files\Hewlett-Packard\Advanced Failover Drivers\Utils` or

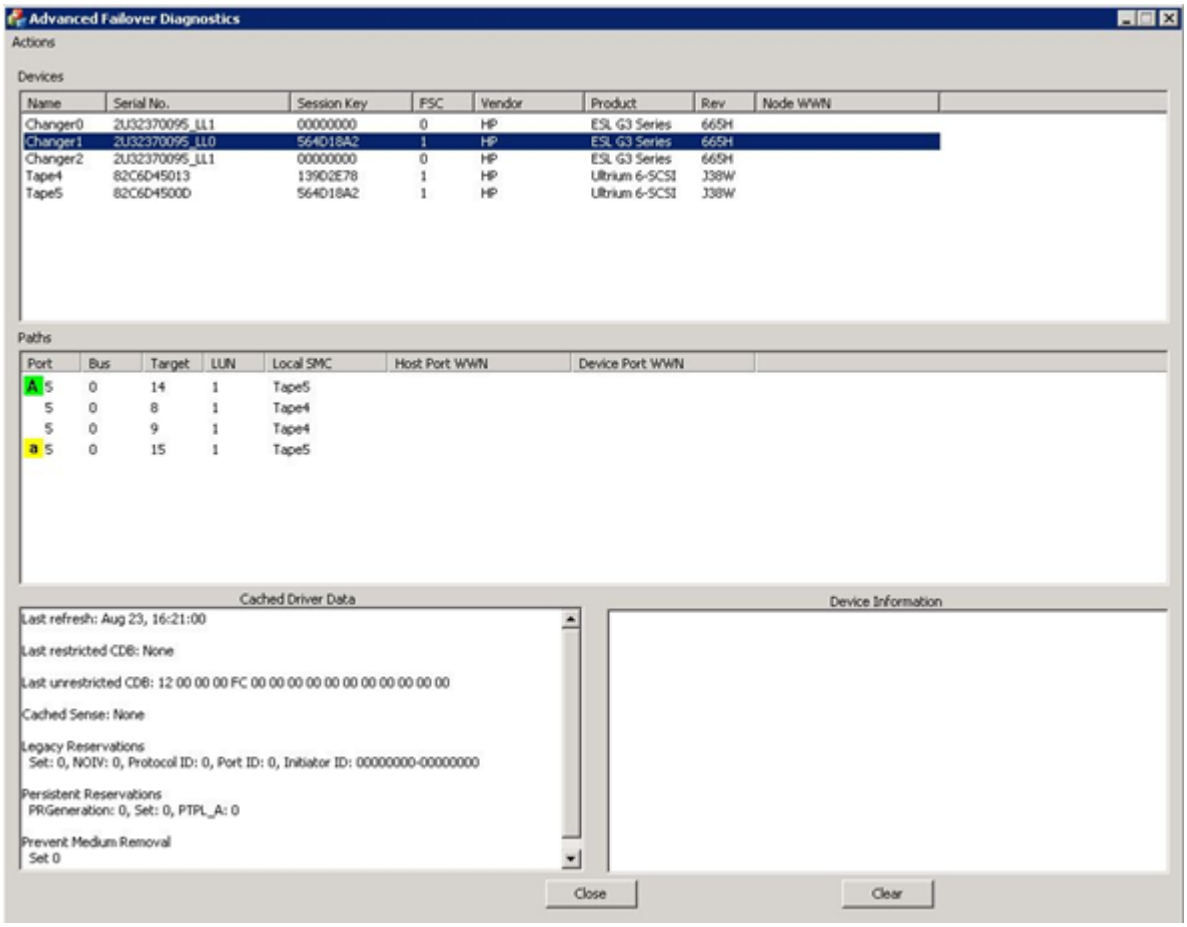
`C:\Program Files (x86)\Hewlett-Packard\Advanced Failover Drivers\HPAdvFoDgn`.

The application consists of two files, `HPAdvFoDgn.exe` and `HPtapeFailover_mpio.dll`.

Operation

The diagnostic application is started by double-clicking its icon. It displays a windows like the window shown in Figure 19 (page 56). The window contains four panes:

Figure 19 Advanced failover diagnostic application



The Devices pane lists the tape drives and media changers that are associated with the path failover drivers. This panel lists all devices that are capable of supporting advanced path failover regardless of whether they are configured to use advanced path failover. In the example above `Changer0` and `Changer2` are paths to an ESL G3 library partition that is not using advanced path failover so two entries are shown for the same changer. Changer1has advanced path failover enabled and is only listed once. Since LTO-5 and older drives do not support advanced path failover, only LTO-6 and newer drives will be listed.

The Paths pane shows information about the device which is selected in the Drives pane. In Figure 19 (page 56), the information is for the media changer named “Changer1.” The capital A in the Port column of the Paths pane indicates the active control path to the SMC device server that is currently being used, and the lower case a indicates alternate active control paths to the SMC device server.

All other paths are passive, i.e., they pass through a passive control path drive (see "Active and passive control path drives" (page 13)).

If the selected device is a tape drive, the capital `A` indicates the active data path, and there will be no lower case `a`.

The Cached Driver Data pane shows the last state of the selected device that was reported by the failover drivers to the diagnostic application. Because changes in the drivers' information about a device are not automatically sent to the diagnostic application, it is necessary to perform a refresh to get the latest state of the drivers. For tape libraries the cached driver data will contain information about reservations and prevent media removal as shown in Figure 19 (page 56).

For tape drives the reservation and prevent media removal information is not tracked by the driver so the Cached Driver Data pane will not include that information for tape drives.

The Device Information pane contains data requested from the tape and changer devices when various actions are performed.

The bottom pane shows failover session information that has been requested for the selected device.

Actions

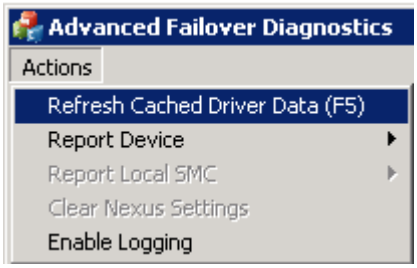
There are several actions that can be performed by the diagnostic application.

- Refresh failover drivers' state information held by the diagnostic application.
- Request current failover information from tape and changer devices.
- Report and clear reservations on changer devices which had been set by hosts that are now offline.
- Enable extra tracing.

Refresh

The information in the Cached Driver Data pane can be refreshed by selecting **Actions→Refresh Cached Driver Data (F5)**.

Figure 20 Refresh Cached Driver Data menu item



Device information

The **Actions→Report Device** menu has three sub-menu items (see Figure 21 (page 57)) which report information on the drive or media changer selected in the **Devices Information** pane. The data is displayed in the **Devices Information** pane.

Figure 21 Report Device menu item

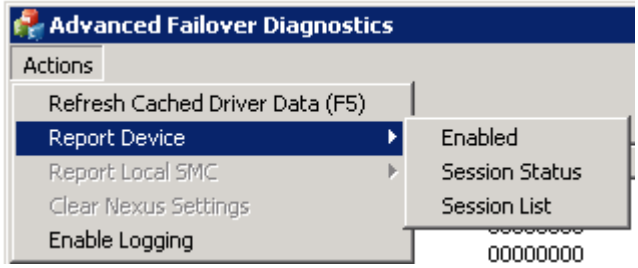


Table 4 Device information

Menu Item	Data
Enabled	Reports whether advanced path failover is enabled for the SSC device server (i.e., for the tape drive data path), and for the SMC device server (i.e., for the media changer controller path)
Session Status	Expected FSC: A command indicator used for management of commands that require synchronization following a link failure.
	PFSE: 1: The device server is using failover via this device server. 0: The device server is not using failover via this device server.
	Failover Session Key: The key for the path (I_T_L nexus) over which the driver is communicating with the device.
Session List	Each entry in the session list contains information about one failover session: Failover Session Key Initiator Worldwide Name

Local SMC device server information

If a changer has been selected in the Devices pane. The **Actions→Report Local SMC** menu is available and has three sub-menu items (see Table 4 (page 58)) which provide an interface to read state information from the selected library. The information is read directly from the library and should match the information retained by the driver. The data is displayed in the **Devices Information** pane.

Figure 22 Report Local SMC menu items

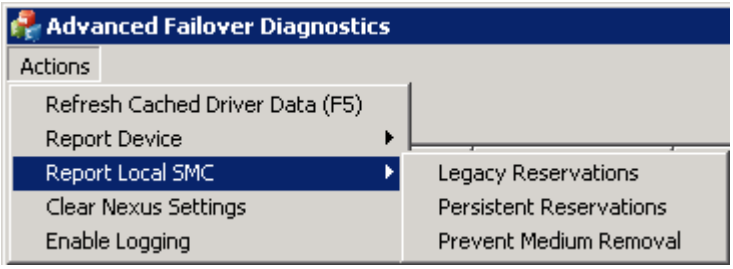


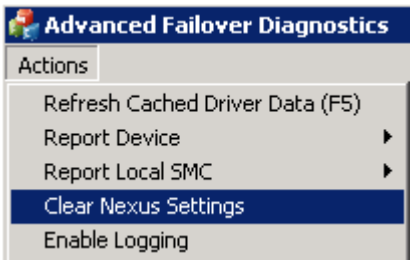
Table 5 Local SMC device server information

Menu item	Data	
Legacy Reservations	SET:	1: An initiator has a legacy reservation established. 0: No initiator has a legacy reservation established.
	NOIV:	1: The following fields are valid. 0: The following are not valid and should be ignored.
	Protocol Identifier:	0: Fibre Channel 6: Serial Attached SCSI (SAS)
	Relative Target Port Identifier	
	Initiator Identifier:	Fiber Channel Port_Name or SAS port identifier
Persistent Reservation	PRgeneration	A counter of persistent reservation settings changes that have occurred.
	SET:	1: A persistent reservation is established. 0: No persistent reservation is established.
	PTPL A:	1: Persist through power loss capability is activated. 0: Persist through power loss capability
	Full status descriptors (see SPC-4)	
Prevent Medium Removal	SET:	1: An initiator has a prevent medium removal established. 0: No initiator has a prevent medium removal established.
	A prevent medium removal descriptor is present for each initiator which has established a prevent medium removal.	
	Prevent:	00b: Medium removal shall be allowed. 01b: Medium removal shall not be allowed.
	Protocol Identifier:	0: Fibre Channel 6: Serial Attached SCSI (SAS)
	Relative Target Port Identifier	
	Initiator Identifier:	Fiber Channel Port_Name or SAS port identifier

Clear Nexus Settings

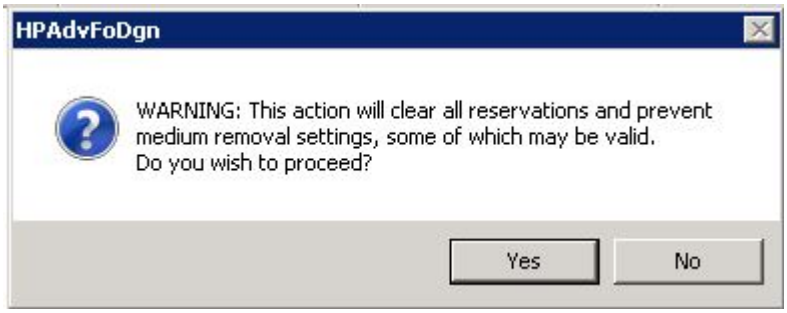
The Clear Nexus Settings action is used to clear legacy and persistent reservations placed on a changer device. This can be used to recover from the loss of a host that has placed a reservation on the changer. If an application is reporting “Reservation Conflict” errors when it attempts to access the changer device or “Medium Removal Prevented” errors occur when attempted to remove tapes from the changer even after the application is no longer using the library, this function can clear those settings.

Figure 23 Clear Nexus Settings menu item



Before the action is performed, the alert shown below is displayed.

Figure 24 Clear Nexus Settings warning



Enable Logging

The Enable Logging action provides a mechanism for capturing run-time diagnostic information from the drivers.

Figure 25 Enable Logging menu item

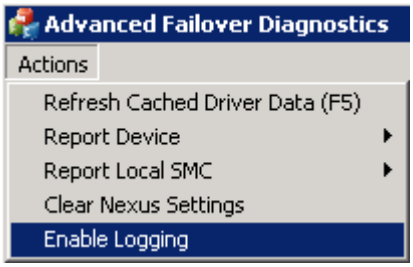
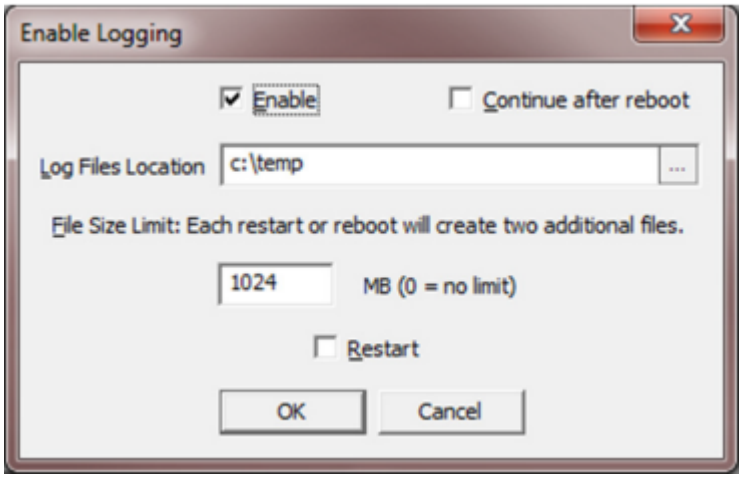


Figure 26 Enable Logging dialog



The **Enable** selection immediately begins capturing driver diagnostic information after **OK** is clicked. The **Enable** setting is not persistent across a system reboot. If the diagnostic information during a reboot is desired, select the **Continue after reboot** option. In the **Log Files Location** field, enter or use the **...** button to designate a local directory for log files. There will be two files created when immediately capturing the diagnostic information:

- tapeapfousbf_YYYYMMDDhhmmss.bin
- tapeapfompic_YYYYMMDDhhmmss.bin

In these file names, YYYYMMDDhhmmss is the date and time **OK** was clicked. After a reboot there also will be two files in the specified location:

- tapeapfousbf_YYYYMMDDhhmmss.bin.NNN
- tapeapfompic_YYYYMMDDhhmmss.bin.NNN

In addition to the date and time, in these file names NNNN will be a number from 1 - 16. The **File Size Limit** value constrains the size of the log files and if the size limit is reached, the oldest log entries are replaced with the new log entries. If 0 is specified as the file size, the log files can become quite large and potentially fill up a hard drive. When **Restart** is selected and **OK** is clicked, any existing log files are closed and new files are created with updated date and time. Each of the files created after a restart or reboot can grow to the specified size. Before sending the log files to HP, run the application, open the enable logging dialog, deselect **Enable** or select **Restart** and then click **OK** to ensure the files have been completely written to disk.

Diagnostic dumps

There are two different diagnostic dump logs which can be saved and sent to HP for analysis. The first is the standard Windows kernel dump which can be saved when a bug check ("blue screen") occurs. The other is a Driver Debug Log generated by a debug version of the advanced path failover drivers. The debug version of the advanced path failover drivers is designated by a 'd' at the end of the driver name (e.g., `hpadvfox64`**`d`**`.exe`) and will be provided by HP support if drive debug logs are required. Debug logs can provide information on failover operations and whether or not a bug check has occurred.

Memory dump setup

To configure Windows to produce a memory dump, see http://support.microsoft.com/kb/254649.

The configuration process includes specifying the name and location for the dump file, as well as the type of the dump. The type should be a kernel memory dump, although the larger complete memory dump is acceptable. Do not select the small memory dump. If a bug check occurs, then after a reboot the file can be retrieved and sent for diagnosis.

Driver debug dump setup

Generating a driver debug dump log file requires installing checked drivers and the DebugView application. This is an advanced technique. For instructions, see "Windows driver debug dump setup" (page 66).

Bug checks

Following a bug check, restart the system and retrieve the kernel dump for transmission to HP. If driver debug dumps were enabled, then retrieve the driver debug log file for transmission to HP.

Hangs

If the system hangs, the system can be configured to allow forcing a system crash from the keyboard. This is explained in http://msdn.microsoft.com/en-us/library/ff545499(v=VS.85).aspx.

If the system hangs after configuring, force the crash and reboot. Then retrieve the kernel dump for transmission to HP.

Linux logs and troubleshooting tools

Report cached reservation information

The Linux advanced path failover driver tracks reservation information for tape libraries to enable rebuilding the reservations if a failure requires changing the drive that is hosting the library control path. These commands dump the reservation information cache buffers to the `/var/log/messages` file and the console.

Legacy reservations:

```
echo legacy > /sys/class/pfo/pfo4/ctrl
```

Persistent reservations:

```
echo persistent > /sys/class/pfo/pfo4/ctrl
```

Prevent allow medium removal conditions:

```
echo prevent > /sys/class/pfo/pfo4/ctrl
```

Debug output control

You can control the level of debug messages being sent to the console.

The default output level is `minimum`.

To minimize the level of debug messages:

```
echo 0x0000 > /sys/bus/scsi/drivers/pfo/debug_flag
```

To maximize the level of debug messages:

```
echo 0xffff > /sys/bus/scsi/drivers/pfo/debug_flag
```

NOTE: Increased debug logging will affect performance.

The definition of all of the bits in the value is beyond the scope of this document.

Reading the trace log

The failover driver maintains an internal buffer of the most recent significant events.

To read the trace log, cat the 'trace' file. For example:

```
cat /sys/bus/scsi/drivers/pfo/trace
```

Library path failover events

When the library detects a path failover, it generates an appropriate event. Path failover events do not always occur immediately following a path break. The device driver will wait until a command is sent, and if the path is still failed, the device driver will perform the failover actions and the library will report the event immediately after the failover. See the library user guide for accessing and interpreting support tickets and log files.

- "ESL G3 events related to advanced path failover" (page 62)
- "MSL6480 events related to path failover" (page 63)
- "MSL library events related to path failover" (page 64)

Table 6 ESL G3 events related to advanced path failover

Event	Description
Library Control Path Failover	A library control path failed and a failover operation to a redundant control path drive succeeded.
Library Control Path Failover Failure	A library control path failed and a failover operation to a redundant control path did not succeed. The library control path is not operational.
Drive Data Path Failover	A drive data path connection failed and a failover operation to the redundant drive port succeeded.
Drive Data Path Failover Failure	A drive data path connection failed and a failover operation to the redundant data port failed. The drive data path is not operational.
Drive Control/Communication Failure	A drive communication failure occurred which prevents drive control and library control path operations.

Table 7 MSL6480 events related to path failover

Event code	Message and description	Details and solution
4037	Loss of redundant data path.	Verify that both FC ports are correctly cabled to the SAN.
4038	The drive configuration failed because of unsupported ADPF features selected.	Advanced path failover, ADPF and ACPF, are only supported on LTO-6 tape drives. Disable advanced path failover for this drive or replace it with a drive supporting this feature.
4039	The drive configuration failed because of unsupported ACPF features selected.	
4040	Data path failover occurred.	Check the cabling and all network components between the affected drive and host computer.
4043	Control path failover occurred. This event applies to Advanced CPF.	If the failover was unplanned or unexpected, verify that the host still sees both the active and passive drives. If necessary, reconfigure a different passive drive for the partition. Check the cabling and all network components between the affected drive and host computer.
4046	The drive configuration failed because of missing DPF license.	Disable path failover or install the necessary failover license.
4047	The drive configuration failed because of missing CPF license.	
4048	The drive configuration failed because of unsupported BDPF feature selected.	Disable basic path failover for this drive or replace the drive with one supporting this feature.
4049	The drive configuration failed because of unsupported BCPF feature selected.	
4050	Basic data path failover occurred.	Check cabling and all network components between the affected drive and host computer.
4053	Manual control path failover from active to passive drive failed; partition may be disconnected from host.	Check cabling and all network components between the affected drive and host computer.
4056	Failed to copy settings from active to passive drive in basic control path failover.	The partition no longer has a passive drive that is available for control path failover. Reconfigure the partition so that at least one drive in the partition is available for control path failover.
4057	Passive control path drive not available for control path failover.	Verify that the configured control path failover drive is present, powered on, and ready to accept the control path.
4058	Disabling active control path drive caused failover to passive one. This event applies to Basic CPF.	If the failover is unplanned or unexpected, verify that the host still sees both the active and passive drives. If necessary, reconfigure a different passive drive for the partition.
4066	Automatic control path failover by disabling LUN drive failed; partition may be disconnected from host.	Check cabling and all network components between the affected drive and host computer.
9040	Control path switched over from active to passive drive.	This event code is used when the user initiates the failover from the library web interface. This is an informational event.

Table 8 MSL library events related to path failover

Event code	Description	Details and Solution
EC	Unable to negotiate for NPIV. Library control path failover has been disabled.	The port of the FC switch connected to the library master drive must be in NPIV mode. Verify the FC switch configuration.
ED	Common control or data path failover issue. Failover has been disabled.	
EF	A data path failover-related error has occurred.	
FF	The master drive was removed without being powered off. Library path failover cannot be performed.	The master drive must be powered off from the library web interface or front panel to activate control path failover.
0x33	Control path failover reported.	A control path failover event occurred. The master drive was successfully switched to the alternate master drive. This is an informational event.
0x34	Data path failover reported	A data path failover event occurred. The active port was successfully changed to the previous standby port. This is an informational event.

Additional tape drive sense codes

Tape drives supporting advanced path failover use vendor-specific SCSI additional sense codes (ASCs) to report certain conditions to the failover drivers. These additional sense codes are handled by the device driver in normal operation and should not be visible to the applications.

Because these ASCs may be visible in device logs and diagnostic tools they are listed in Table 9 (page 65).

Table 9 Advanced failover vendor specific additional sense codes

ASC	ASCQ	Description	Meaning
82h[1]	93h	FAILOVER SESSION SEQUENCE ERROR	Failover is enabled but the device driver has not opened a failover capable connection to the device. Check that the failover driver is installed and attempt to reopen the device.
82h[2]	94h	FAILOVER COMMAND SEQUENCE ERROR	The advanced path failover system is unable to ensure that the command will be executed in the proper sequence. Close all connections to the device and then restart application services.
82h	95h	DUPLICATE FAILOVER SESSION KEY	The failover driver attempted to use a failover session key that is currently in use by another host. The driver should automatically try a different key. Restart application service if any errors occur.
82h	96h	INVALID FAILOVER KEY	The failover driver attempted to use a failover session key that is not valid. Retry opening the device or restart application services.
82h	97h	FAILOVER SESSION RELEASED	An event caused the device to close the failover session that was in use. The driver should automatically open a new session, if not restart application services.
82h	98h	SMC STATE CHANGED	A normal event informing the device driver that a event has caused a change in the media changer state information. The device driver should automatically update media changer state information and continue.
82h	99h	FAILOVER SMC DEVICE SERVER MOVED	A normal event informing the device driver that this path is not an active control path. The device driver will automatically use a different path.

[1] If advanced path failover is enabled on a tape drive or a library, and the advanced path failover driver is not installed on the host, this error will be reported to applications attempting to read/write the tape drive or move media using the changer.

[2] In rare cases when all paths to a tape drive are lost while commands are in progress it is possible for this error to be reported once when the connection is next opened. Closing the device and retrying the connection will clear this condition.

12 Advanced troubleshooting techniques

The techniques in this chapter assume an advanced level of experience.

Windows driver debug dump setup

Generating a driver debug dump log file requires installing checked drivers and the DebugView application.

Drivers with debug capability are available from HP technical support (http://www.hp.com/support).

1. Uninstall the release drivers as explained in "Uninstalling drivers" (page 37).
2. In Windows 2008 or 2012 systems, place the system in Test Mode by opening a command window and entering the command `bcdedit testsigning on` and then restarting. After restarting, the desktop will display `Test Mode` in the lower right. If this step is not done, then after installing a checked driver, the system will boot into Recovery Mode. If the `bcdedit` command is not recognized, it is not required for that system.

   For further details, see:

   http://msdn.microsoft.com/en-us/library/windows/hardware/ff553484(v=vs.85).aspx
3. Configure the location and type of the debug output to save a kernel dump in a known location. A kernel dump is preferred to the much larger complete memory dump.
4. Install the appropriate checked drivers for your operating system using the procedure in "Downloading and installing the drivers" (page 36). When prompted whether to allow installation of an unsigned driver, allow installation.
5. In Windows 2008 or 2012 enable the debug print filter by editing the registry:
   a. Run a registry editing application (e.g., `Regedit.exe`) with administrative privileges.
   b. Navigate to `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Debug Print Filter`. You may need to create the key `Debug Print Filter`.
   c. Add a new sub-key DEFAULT (this is different from the automatically created sub-key "(Default)") with type `DWORD` and set it to `15 (0xF)`. The registry value can be created by sending this command from a command window that has been opened with administrative privileges.
   d. As an alternative to steps Step 5.a through Step 5.c, open a command window and issue the command:

      ```
      reg add HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Debug Print Filter" /v DEFAULT /t REG_DWORD /D 15.
      ```
   e. Restart the machine after updating the registry for the changes to take effect.
6. Download DebugView from http://technet.microsoft.com/en-us/sysinternals/bb896647 and unzip the files to a local folder. There is no installer.
7. Run DebugView and configure it to capture Kernel-Mode debug output by checking **Capture→Capture Kernel (Ctrl+K)**.
8. To capture driver debug messages during boot time, select **Capture→Log Boot**.
9. Select a file to receive the log with **File→Log to File** or **File→Log to File As...**.

The help file for DebugView is comprehensive; please refer to that for details. If Help does not work because the right pane displays `Navigation to the webpage was canceled`, locate the `dbgview.chm` file in the destination folder. Right-click on the file, select **Properties**, and on the General Tab on the lower right click **Unblock**.

13 Support and other resources

HP technical support

Telephone numbers for worldwide technical support are listed on the HP support website: www.hp.com/support.

Collect the following information before calling:

- Technical support registration number (if applicable)
- Product serial numbers
- Product model names and numbers
- Error messages
- Operating system type and revision level
- Detailed questions
- An L&TT Support Ticket, which can be downloaded to a USB drive from the front panel or downloaded to a file with the remote management interface.

For continuous quality improvement, calls may be recorded or monitored.

HP websites

For additional information, see the following HP websites:

- www.hp.com — HP corporate website
- www.hp.com/go/storage — HP storage products
- www.hp.com/go/ebs — compatibility information
- www.hp.com/support — HP Support website
- www.hp.com/support/mslg3tstree — interactive troubleshooting tool
- www.docs.hp.com — documentation about HP products
- www.hp.com/support/tapetools — HP Library & Tape Tools diagnostic software

The Fibre Channel specifications, including the specifications for NPIV, are maintained by the INCITS/T11 Committee. See http://www.t11.org.

Copies of the Fibre Channel specifications are available from the INCITS store. See http://www.incits.org.

Typographic conventions

Table 10 Document conventions

Convention	Element
Blue text: Table 10 (page 67)	Cross-reference links and e-mail addresses
Blue, underlined text: www.hp.com	Website addresses
Bold text	• Keys that are pressed • Text entered into a GUI element, such as a box • GUI elements that are clicked or selected, such as menu and list items, buttons, tabs, and check boxes
Italic text	Text emphasis

Table 10 Document conventions *(continued)*

Convention	Element
`Monospace` text	• File and directory names • System output • Code • Commands, their arguments, and argument values
`Monospace, italic` text	• Code variables • Command variables
`Monospace, bold` text	Emphasized monospace text

WARNING! Indicates that failure to follow directions could result in bodily harm or death.

CAUTION: Indicates that failure to follow directions could result in damage to equipment or data.

IMPORTANT: Provides clarifying information or specific instructions.

NOTE: Provides additional information.

TIP: Provides helpful hints and shortcuts.

Subscription service

HP recommends that you register your product at the Subscriber's Choice for Business website: www.hp.com/go/e-updates.

After registering, you will receive e-mail notification of product enhancements, new driver versions, firmware updates, and other product resources.

HP-authorized reseller

For the name of your nearest HP-authorized reseller:

- In the United States, call 1–800–282–6672
- Elsewhere, visit the HP website: www.hp.com, then click **Contact HP** to find locations and telephone numbers.

Learn more at :

- www.hp.com/go/tape

A Known issues and workarounds

Path failover issues are observed on Windows Server 2012

Symptom: On Windows Server 2012, path failover issues are observed, even after installing the advanced path failover driver and rebooting the server twice. The installation file used was: `HP_StoreEver_High_Availability_Path_Failover_Driver_Windows_2012_2012_R2_Z7550-01470.exe`

Workaround: The installer for the initial release of the advanced path failover driver has a defect that results in an incorrect installation on Windows Server 2012. The defect in the installer has been fixed.

Download and install the updated driver package.

1. Uninstall the advanced failover drivers.
   a. Select **Start→Programs→Control Panel**.
   b. Select the **Advanced Failover Drivers** entry and then click **Uninstall/Change**.
   c. Follow the provided prompts to complete the driver removal.
2. Reboot the server.
3. Download the latest Advanced Failover Drivers for Windows Server 2012 from the HP website.
   a. Navigate to http://www.hp.com/support/storage.
   b. Click **Tape Storage**.
   c. Click **Enterprise Class Tape Libraries** (for ESL G3) or **Tape Libraries** (for MSL6480).
   d. Click **HP StoreEver ESL G3 Tape Libraries** (for ESL G3) or **HP StoreEver MSL6480 Tape Library** (for MSL6480).
   e. In the **Download options** tab, click **Drivers, software & firmware**.
   f. For the ESL G3, select your product.
   g. In the **Operating System** drop down, select **OS Independent**.
   h. Click **Driver — Storage Tape**.
   i. Click **Obtain software** for the High Availability Failover Driver for your operating system.
   j. Click **Receive for Free**.
   k. Follow the prompts to download the driver package.
4. Double-click the installer for your operating system to install the Tape Upper Bus Storage Filter driver.
5. Restart when requested.
6. After the system restarts, the installer will continue installing the Tape Multi-Path Intermediate Class driver.

The current implementation is failure tolerant only and not intended to fix unstable SAN environments.

Symptom: Device connectivity lost after several closely spaced path failures. If several closely spaced path failures occur on all of the available paths the operating system might not detect a path change and report that to the driver causing a loss of connectivity with the device.

Workaround: Locate and repair the SAN faults. The driver is not always able to recover if both the active path and the standby path have faults.

The current implementation of the Windows driver uses the first path to a device that was successfully found.

Symptom: The device driver does not connect to the preferred path after a system boot or device rescan.

Workaround: The driver prefers the first path in the hardware scan performed by the operating system. If a particular path is preferred, load the HBA for that path in the lower numbered hardware location.

The driver does not perform speed or performance comparisons of all available paths to a device to select the best one as a primary.

Symptom: The device driver does not connect to the highest performance path after a system boot or device rescan.

Workaround: The driver prefers the first path in the hardware scan performed by the operating system. If a particular path is preferred, load the HBA for that path in the lower numbered hardware location.

In multi-host environments, device discovery on a newly introduced or rebooted host could be problematic if the library is not idle during the discovery. (Windows and Linux)

Symptom: A host in a multi-initiator environment does not discover a path to the library controller when it is booted or the devices are rescanned when another initiator is using the library. Some applications create an exclusive connection to the tape library and prevent drivers from performing proper discovery and binding. Note that this is not unique to the HP APF drivers and can occur in environments not using the APF drivers as well.

Workaround: For Windows, reboot or rescan devices while the library is not being used. For Linux, reboot or remove and re-insert the advanced failover drivers using `modprobe` while the library is not being used.

A failure of the active control path drive and activation of the passive control path drive near the same time that a reservation is being released may result in the reservation not being released correctly.

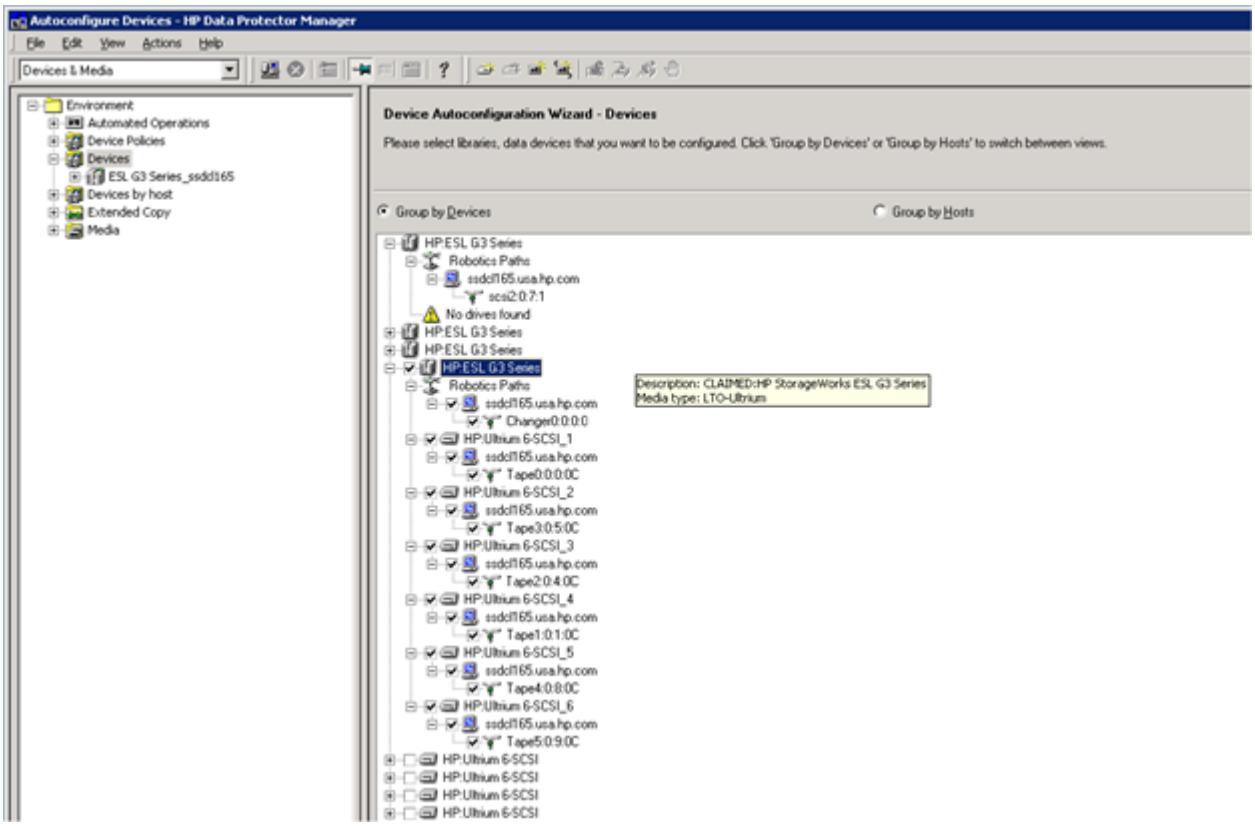
Symptom: Tape library access commands fail with "Reservation Conflict" errors or "Medium Removal Prevented" errors. In rare cases where access to all paths on the active control path drive is lost at the same time that a reservation or prevent media removal setting is in the process of being changed or if all paths are lost to an active control path drive in a multi-initiator environment and one host does not recover from the path failure it is possible to have a reservation or prevention setting that is no longer associated with a host. Note that this is not unique to the APF driver and is most likely to occur in traditional multi-path configurations.

Workaround: Both the ESL G3 library font panel and the Windows diagnostic application provide a method for clearing the stale settings. In the Windows diagnostic application it is found under **Actions→Clear Nexus Settings**.

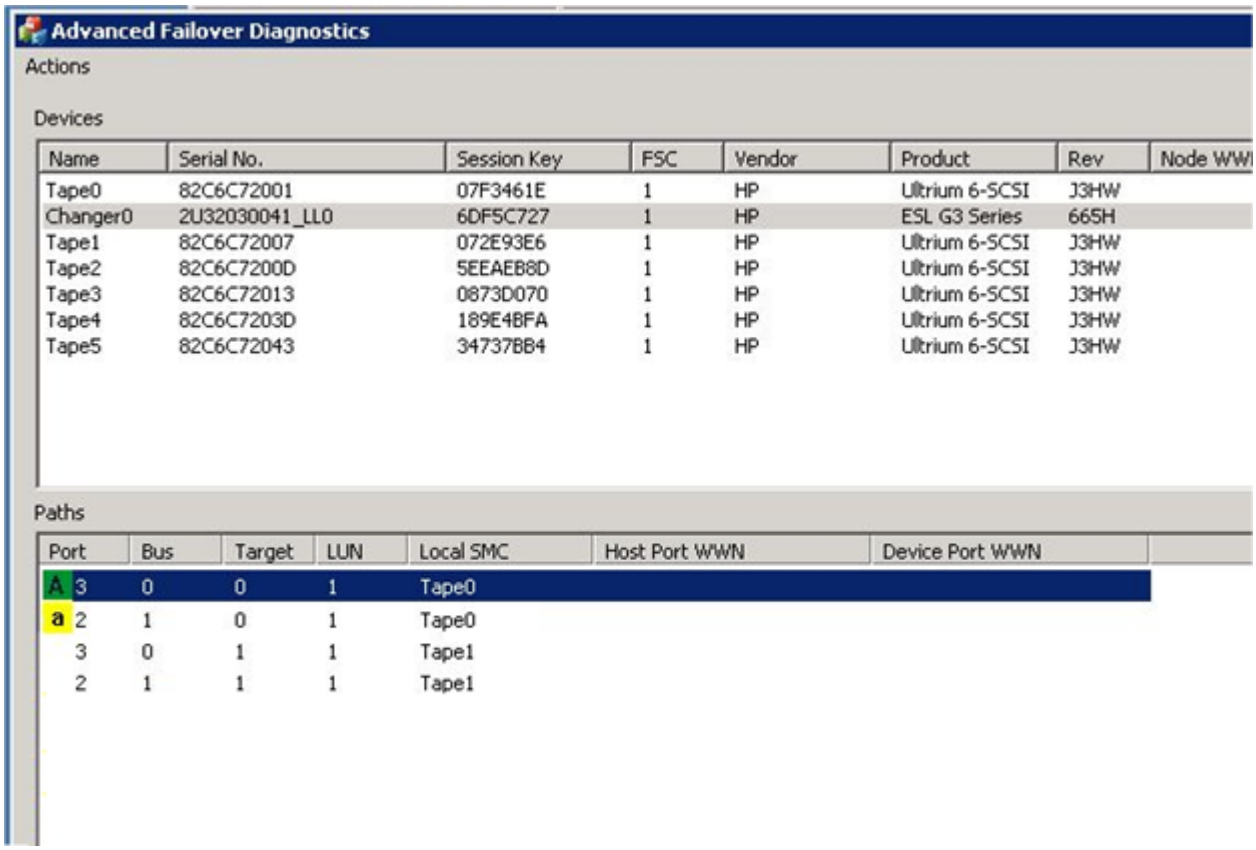
If the Windows diagnostic application or ESL G3 GUI is not available, most settings can be cleared by using the library GUI to power-cycle the tape drive hosting the library controller. Persistent reservation settings must be cleared using the application that established the settings.

B Data Protector device discovery with advanced path failover

When using the Data Protector Autoconfigure functionality, Data Protector will discover both active and passive control and data paths to the library robot control and drive paths respectively. Data Protector will associate all active data paths with the active control path, and can be identified by the library in the list that includes the selection box. All other listed libraries will correspond to passive control paths. All active data paths will be listed in the collapsed tree under the active control path. The following example, Data Protector Autoconfigure discovery result, shows an ESL G3 library with 6 LTO-6 drives and the active control and data paths associated under the library.



When configuring devices manually, Data Protector will also find all active and passive device paths for robot and drive. Data Protector recognizes the paths correctly and marks all passive paths with a red 'x' and the active path with a green 'check'. To verify Data Protector has discovered the active paths correctly, the Advance Failover Diagnostic tool can be used to cross reference all paths and symbolic driver names. The following example shows the Diagnostic tool display of the above library and 6 LTO drives and their associated paths:


Advanced Failover Diagnostics
Actions
Devices
Name Serial No. Session Key FSC Vendor Product Rev Node WW
Tape0 82C6C72001 07F3461E 1 HP Ultrium 6-SCSI J3HW
Changer0 2U32030041_LL0 6DF5C727 1 HP ESL G3 Series 665H
Tape1 82C6C72007 072E93E6 1 HP Ultrium 6-SCSI J3HW
Tape2 82C6C7200D 5EEAEB8D 1 HP Ultrium 6-SCSI J3HW
Tape3 82C6C72013 0873D070 1 HP Ultrium 6-SCSI J3HW
Tape4 82C6C7203D 189E4BFA 1 HP Ultrium 6-SCSI J3HW
Tape5 82C6C72043 34737BB4 1 HP Ultrium 6-SCSI J3HW
Paths
Port Bus Target LUN Local SMC Host Port WWN Device Port WWN
A 3 0 0 1 Tape0
a 2 1 0 1 Tape0
3 0 1 1 Tape1
2 1 1 1 Tape1

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W